# Electrical Review

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## *MODERN SHOP METHODS.*

In a recent address given in London, Mr. George Westinghouse laid stress on the use of machinery in shop operation. He described a large steel plant where practically all the work was done automatically by machinery, the men in charge having nothing to do but to touch a lever and to see that all went well. The point is made that we, in this country, have been forced into this method of operation on account of the scarcity of labor; but it is worthy of notice that such a complete installation as was described could not have been possible with any means of transmission at present available other than electricity. The advantages of electrical operation do not need to be enlarged upon here, but no system less efficient and less flexible could accomplish the results which are an every-day matter in many large establishments.

## *ELECTRIC SIGNALING TO MOVING TRAINS.*

Wireless telegraphy, as to-day understood, would probably not have prevented the terrible railroad accident in New Jersey, near Plainfield, recently, by which more than a score of people lost their lives; but the day may come when this method of signaling will be available in railway operation. There are, of course, many and serious difficulties in adapting this system to such work. If this method is to be used to establish communication between trains and block stations, means must be found to prevent interference of one station or one train with another; but since it will not be necessary to transmit messages—signals being sufficient—this fact should simplify the problem considerably.

*Systems Using Metallic Circuits.*

There are, however, other ways of communicating with moving trains which could be adopted at once. In certain of these systems a contact wire or rail is placed along the track with suitable collecting devices on the train. The circuit may be carried, if desired, to the train despatcher's office, or merely to the next block station. By means of this circuit signals can be made in the cab of a locomotive. This may consist of ringing a bell, in addition to some visual signal, thus attracting the attention of the engineer through two senses, and making the system doubly safe. Indeed, communication between a station and a train by means of the telephone or telegraph is not difficult. We have had in our electric railway work sufficient experience with moving contacts to feel fairly confident of their operation. These systems should not replace the stationary signal systems as used to-day, but merely supplement them.

*Control of the Locomotive by the Train Despatcher.*

In addition to giving signals to the engineer, it is possible to equip the locomotive so that the operator at the block station can, if it be necessary, stop the locomotive himself. In one system proposed, which seems to be an elaborate extension of the track models sometimes installed in signal towers, each train is represented by a model which moves over the track, following the movements of the train itself. Thus the operator, by glancing at his model, can see the position of each train and regulate his orders accordingly. By this system the operator can not only signal to the various trains, but, if necessary, he can compel any one to stop. The plan seems to be rather complicated, and would doubtless be delicate in operation. Moreover, the human element would not be eliminated, although, if the system can be made to work effectively, it would certainly add much to the safety of railway operation.

*Automatic Block Signaling.*

In these systems, so far as touched upon, the human element still enters, but there is no reason why an automatic block system should not be devised. Indeed, there would seem to be little difficulty in so doing. This should be used in conjunction with a proper signal system for the information of the engineer. These orders could be transmitted, as is done now, by stationary signals or by signals transmitted to the engine cab.

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The first turbo-generator was built in 1884. In six years there were about 360 turbine plants ranging from quite small units up to 130 horse-power. To-day there are in use and building turbines aggregating over 300,000 horse-power, the largest unit being 3,000 horse-power. The difficulties in designing large turbines have been overcome, and there are being constructed now units with a capacity of 5,000 horse-power. From this it would seem that unless the present indications are at fault we may expect a rapidly increasing use of the steam turbine.

## ELECTRICAL DEVELOPMENTS.

In this country we like to do things on a vast scale, for nowhere else are the advantages and economies of concentration and bigness better appreciated. That electrical engineering is no exception to this is shown by a consideration of the stupendous electrical developments now in progress or planned for in the near future.

*Increasing Size of Power Plants.*

All lines of electrical work are growing rapidly. Electric lighting is extending, and electric railways are spreading over all sections of the country. But probably no phase of this is more striking than the sizes of the power-houses which are being constructed to furnish these undertakings with electrical energy. Take New York as an instance. The Edison waterside station, when all the machinery is in, will have a normal output of 56,000 kilowatts; the Metropolitan station, for the surface lines, a normal capacity of over 38,000 kilowatts; the station for the Manhattan elevated systems will, when complete, have a normal output of 50,000 kilowatts; the normal output of the main station of the Rapid Transit Company will be 50,000 kilowatts, and that for the Kingsbridge station will be 28,000 kilowatts. These figures represent the rated outputs only, the overload capacities of these various stations being from thirty to fifty per cent greater than the figures given. In addition to these, the Pennsylvania Railroad Company contemplates erecting two plants for operating the trains to its terminals in New York. These will aggregate 75,000 kilowatts, and there will also be a plant of about 80,000 kilowatts to operate trains over the New York Central terminals. The total normal output of all these stations would probably be in the neighborhood of 400,000 kilowatts, with an overload capacity of about 550,000 kilowatts.

*Niagara Developments.*

The only other spot in the world where such stupendous power developments are going on is at Niagara. There, at present, the total output of the generators in operation is something under 100,000 horsepower, but when the work now under way has been completed, this figure will be increased at least three times. It will, however, be some years before these plants are completed, and probably before that other large installations will be under way in that locality. Many other magnificent power plants are scattered throughout the country, but no section can compare with either of these in point of total capacity.

*Electric Railways.*

The next few years will doubtless witness a remarkable extension of electrical railway systems, besides the instances mentioned above, where other considerations have forced the adoption of electricity. There are a number of standard-gauge roads which are about to adopt this method of transportation for certain sections of their lines. This is notably true in Europe. Two large systems in England have already given out their plans. This application will be greatly accelerated if the tests now being carried on with the several systems of single-phase alternating-current motors for traction purposes prove successful, as such a system would effect a marked saving in copper and machinery.

*Urban Roads.*

Electrically operated urban roads have practically forced all other systems from the field, and plans now being considered for Chicago contemplate abandoning entirely the cable, which has still survived there, for an electric conduit system. Improved transit facilities in many cities have so greatly increased the amount of travel that our streets have become inadequate in many cases. This has necessitated the construction of subways. Work on these is now well advanced in New York, and an elaborate system has been proposed for Chicago. Other cities, notably London and Boston, have large systems already in successful operation. None of these could be conducted satisfactorily were it not for the electric motor.

*Electrochemistry.*

Electrochemistry, about which one hears less, since it in no way concerns the general public except by supplying the finished product, is growing at a truly wonderful rate. No one can appreciate this without making a visit to some of the centres of the electrochemical industry.

*Work for the Year.*

While we have touched on only the most notable instances, development is going on at an increasing rate in all lines of electrical application. The outlook for the future is most promising, and as indications point to-day, this coming year will have its full share of the work.

## THE TELEGRAPH AND THE TELEPHONE.

There seems to be but little cause for anxiety on the part of the companies which are operating our present methods of transmitting intelligence. In telegraphy, the Morse system has not been displaced by the high-speed machine telegraphy, but the latter will probably develop a field of its own. One of the large telegraph companies has made a study of a printing telegraph system and is using this in connection with the older system. Machine telegraphy may be divided into two classes—that intended to print the message directly and that designed principally for high-speed transmission. There is work for all three methods.

*Ocean Cables.*

It is evident that the cable companies do not anticipate any great reduction in their business. Their confidence in the security of cable investments is well illustrated by the recent laying of the cables in the Pacific Ocean.

*Telephones.*

The telephone has developed a field distinctly its own, and although its use has increased at a marvelous rate, reports from the telegraph companies show that it has not interfered with their business. The Pupin system has made possible wider extension of telephone communication, but it does not appear that even this affects other systems of communication. Recent tests of the Pupin system have shown very encouraging results, and the inventor himself remarked recently that he would not be satisfied with anything less than transatlantic telephony.

*Wireless Telegraph.*

Wireless telegraphy has developed and improved so rapidly that new achievements are announced before we have ceased talking about the previous ones. The outlook for these systems is bright, but other means of communication need feel no anxiety; there is room for all, and the more methods we have for sending messages the more messages will be sent.

### IMPROVEMENTS IN TRANSPORTATION FACILITIES.

On another page of this issue Dr. Louis Bell, who has made a careful study of railway problems since the first introduction of electric transportation, offers some suggestions for materially improving street railway service in large cities.

*Congestion Due to Immense Office Buildings.*

Dr. Bell calls attention to the effect on traffic of large office buildings. These should be treated as theatres, pleasure resorts and other places where large crowds congregate. It is true that the average office building does not turn out as large a crowd in as short a time as a theatre, but the fact that it is customary to group these large buildings in one section of the city, produces conditions which are as troublesome as a ball-ground. It is impossible to handle the traffic of a twelve-story city with a one-story street railway system, and it is even doubtful whether the three-story system of elevated surface roads and subways will prove sufficient in the worst cases, such as New York.

*Choice of Route.*

There are several means of materially alleviating the crowded cars in some cases. Where there is a choice of route, the passenger should select that which is least crowded and thus distribute the load. By rerouting the lines so that the long haul lines will not catch the short haul traffic, not only would the cars be less crowded, but it is probable better time could be made due to the less frequent stops. It is to be regretted that neither of these suggestions can be of very great service in New York, on account of its peculiar topography. The island being long and narrow, practically all the traffic is in the direction of its length.

*Standing Passengers.*

The question of "no seat no fare" is touched upon, and it is shown that it would be impracticable to enforce such a regulation, as it would tend to produce greater crowding of the cars. Moreover, it is impossible in many cases to provide each passenger with a seat, and to attempt to do this would greatly increase the number of cars on the line and cause much delay. If a passenger was compelled to wait as car after car passed him until one came along with a vacant seat, there would be far more complaining than the excessive overcrowding at present causes. It is true that in some countries the passengers are not allowed to stand, but abroad the general public is not so entirely dependent on the street car service as we are here, and in England, at least, it is proposed on certain lines to allow a limited number of passengers to stand, if, indeed, this is not already being done.

*Analogous Problems.*

This problem is similar to a number of engineering problems in that the greatest part of the work must be done during a few hours, but the plant must be kept in operation throughout the entire day. In the power stations the load can be distributed more uniformly by the use of accumulators, but there seems to be no practical way of distributing the travel. If we worked on shifts throughout the whole day of twenty-four hours, the problem would be much simplified!

### AUTOMOBILES.

The automobile is becoming an important factor in both city and country, and in both instances it works for the general good. In the city by doing away with horses, the hygienic conditions would be much improved, to say nothing of the greater comfort resulting from less dust and dirt upon the streets. The greater speeds attainable will have several beneficial effects. Street railway traffic will suffer from less interference, and the wider range of travel of the automobile over horses will result in a decrease in the number of vehicles. The increased capacity over horses will also work to the same end, while the use of rubber tires will cause less wear and tear on the pavements.

*Electric Traction in the Country.*

In the country the automobile is already becoming a powerful assistance to the farmer in the movement for good roads. Good roads add to the value of all real estate and make for the general prosperity of the state. Heretofore, the farmer has been the one chiefly concerned in the building and maintenance of good highways. Now the automobile brings to his assistance the wealth and fighting abilities of the cities. With both city and country demanding road improvement, it will be difficult for legislatures to refuse to do something toward its realization. This country is undoubtedly far behind all other civilized countries in the character and extent of its highways.

### PRECAUTIONS IN WIRING.

A very distressing accident occurred recently at the Fulham Public Baths in London, whereby two men lost their lives. These baths are porcelain lined, with slate partitions between adjacent apartments, and are electrically lighted. The baths are drained by a gun-metal waste pipe and are lighted with a 200-volt alternating-current circuit which is run through an iron pipe along the top of the slate partitions. In some inexplicable way, one wire of the circuit became grounded while the other made contact with the iron pipe enclosing them. This pipe was continuous, but was not connected to the ground at any point.

The unfortunate bathers placed their hands upon this pipe while standing in the water, thus making excellent contact even though they may not have been touching the drain pipe. In one case, the cry of the bather brought assistance, but too late to save his life. The other was dead when discovered. Several persons received shocks upon touching the pipe carrying the wires.

The accident was undoubtedly the result of an unusual combination of events, and should impress us with the necessity of in no way relaxing the requirements for electric light wiring. Of course, it is plain to every electrician that if the pipe had been carefully grounded the accident could not have happened, but it is probably true that few inspectors would have tested the pipe or even have ordered it to be grounded. While the underwriters' rules do not require the grounding of low-potential circuits, the general opinion is in favor of this practice. But no exception should be made to the grounding of exposed metallic conduits.

# The Overcrowding of Street Cars.

By Dr. Louis Bell.

I WATCHED conductor No. 41144 with great sympathy as he rang up the hundred-and-fourth fare on a car built to seat twenty-two. I was fairly comfortable, wedged in on the back platform between a haggard gentleman who had been mixing onions and gin and a severe old lady who sniffed and eyed me suspiciously, but No. 41144 was having a session with the strenuous life. He wormed his way through the jam, gathering nickels, perpetually dodging feet and elbows, with one eye askew, like a lobster's, watching for signals to stop. Occasionally he regained the platform, wheezing for breath, but still good-natured, and gasped out the name of a street. My particular line is not especially crowded as lines go, but the scene was a familiar one and it started me on a train of thought regarding the causes of the difficulty and the possible remedies. Regularly every winter the same conditions recur, with increasing severity, and Civis, Victim, and Old Subscriber write damnatory letters to the newspapers demanding more cars, bigger cars, and a no-seat-no-fare law. Now and then some intrepid street railway man rises to reply, and plainly shows by incontrovertible statistics that the average car seats thirty and the average number of passengers per car is twenty-seven, so that overcrowding is, on the average, impossible. But the dial tells no lies, and when it shows eighty or a hundred fares near the beginning of a run, substantially these numbers of passengers are aboard, as actual count verifies.

There is an old street railway adage which avers that the profit is in the passengers who stand, and the public is very prone to charge up overcrowding to the deliberate parsimony of the street railway company, neglecting all other factors in the problem. Now, a street railway is very far from being an eleemosynary institution, and, as a rule, it does not run two cars where the passengers can be crowded into one. There is far more profit in one car with a hundred passengers than in two cars with fifty passengers each, and up to the point where overcrowding actually drives possible passengers to walking there is no apparent loss of profit, but, nevertheless, I think I am correct in the supposition that the average street railway manager would gladly relieve the overcrowding long before this point is reached if he could do so in any reasonable manner. After all, the good will of the public counts for considerable, and it is not willingly forfeited for small cause when the matter really comes to an issue.

The fundamental cause of overcrowding is the combination of a twelve-story city with a one-story street. A circus or a base-ball game is a source of crowding that everybody can see and comprehend, but a modern skyscraper can pour out almost as dense a mass of humanity every evening and get no popular credit for it. The tracks available on one or two streets are simply inadequate to handle the crowd, and President Vreeland, of the Metropolitan road, New York City, did not exaggerate when he intimated that there were lines on which all the cars that it was physically possible to operate would not suffice to furnish seats for the passengers desiring to ride at certain hours.

This difficulty is inherent in large cities and represents a condition which street railways are in no way responsible for. Twelve-story cities demand two or three-story facilities for transportation, such as New York is about to acquire. But overcrowding occurs at places and times other than those just indicated, so that it does not suffice to charge it up to unavoidable conditions. One of its commonest and most irritating causes is the insufficiency and irregularity of the schedules as actually in force. The number of cars which pass a given point is no criterion of the actual service given. First and last, I have attended a good many public hearings on street railway affairs, and when the existing accommodations are called in question the procedure is generally as follows: The objectors complain loudly of insufficient cars at some given point, and the railway promptly makes reply by showing from its alleged records that, let us say, 500 cars daily pass the said point, or one every two minutes during the hours of practical service. Now, admitting the accuracy of the figures, which I am not always inclined to do, this may mean good service or very bad service. Sometimes the cars in both directions are quietly included in the count, and there may be four or five lines of cars, only one of which is of any practical use to the objector. But the real point of the matter, so far as it relates to overcrowding, is as follows: Twelve cars per hour in a given direction means on its face a car every five minutes, but, in fact, it may and often does mean three cars, differently routed, every fifteen minutes. Cars thus run in bunches mean bad service, and imply probable overcrowding on very small provocation at either end of the line. Even if the cars follow the same track in and out for a long distance, the first of the bunch catches most of the waiting passengers, unless it is already jammed, so that the practical result is most unpleasant.

A similar trouble arises from unwise routing of the cars. If it can be avoided a heavy long-distance line should be cut loose from the additional burden of the short-ride passengers by skillful routing. Otherwise the latter pile upon it indiscriminately merely because it was the first car to pass and load it almost to collapse. When this source of trouble is combined with the one just mentioned service is in a very bad way indeed. And passengers can not be blamed for boarding the first car available when they do not know whether the next one will be along in one minute or fifteen. Bunched cars may run in any order, and the order at that particular trip can not be foretold. In general, schedules are only useful to the extent that they are actually maintained. When cars are running every two or three minutes it is almost a matter of indifference whether the passenger catches one or another, but when they follow a ten or fifteen-minute schedule the disarrangements that actually occur very frequently mean that some car will be outrageously overcrowded. And a twenty-minute schedule is for most purposes an abomination. When in addition to the sources of difficulty here mentioned one finds a disposition on the part of the railway company to keep the number of cars down to the lowest feasible limit, the cars are naturally jammed much of the time, but it is my purpose here to point out that this unpleasant result is only too easily reached even when the total number of cars operated is as great as could reasonably be expected.

Another matter not generally appreciated is the immense difference in seating capacity between closed and open cars which produces totally different conditions in summer and in winter. An open car with ten cross-seats will accommodate

fifty persons, while a closed winter car with lengthwise seats will seat only about thirty for the same length over all and approximately the same weight. The two take up the same room on the street, and the latter loses considerably in the time of taking and discharging passengers, so that it is fair to say that for equal seating capacity the summer schedule would have to be doubled up in winter. Closed cars with crosswise seats and a centre aisle help the matter a little, but not very much on account of greater time lost in getting passengers in and out. Bearing this in mind, and standing on a busy street during the rush hours on an autumn day when the excursion travel is off, but the open cars are still on, one gets a very vivid idea of the difficulties which would follow doubling the number of cars in an attempt to seat all the passengers.

And now as to remedies. In the crowded part of a city the first step toward handling the enormous traffic should be a conjoined effort of the public and the street railway companies to operate more cars, not only during the ordinary rush hours, but to a less extent at other times. Any facilities which tend to aid transportation for a moderate period on each side of the ordinary rush will help on the good cause. If one feels confident that whenever he leaves his office there is a strong probability of having to stand, he will make little effort to avoid the worst of the rush. If the cars are run on their minimum intervals during longer hours there will be a strong tendency to scatter the traffic and the crowding will be materially relieved. This is "up to" the railway companies, and if they do not of their own accord come to time they should be compelled to. On the other hand, municipal regulation of vehicular traffic should, along main lines of street-car travel, be worked for all it is worth. It will enable more cars to be run at better average speed. This is one of the wise measures proposed for helping matters in New York. And the cars should be as easy of access as possible, hence vestibules should be used with caution on urban lines. There is a great chance for reform in the operation of cars run on a ten-minute or fifteen-minute schedule as on many suburban lines. They should not be scheduled or allowed to run in bunches, but should be scattered as nearly as possible at uniform intervals. Even the best planned schedule may be disarranged by a blockade, but there is no excuse for a bad initial arrangement. It is often impracticable to increase the service on all suburban lines, but those which do not run to the worst part of the urban congested district should be pushed to the limit. I have often referred in print to the foolishness of trying to run all cars to a common distributing point. The Boston rapid transit system is peculiarly ill planned in this respect, and it is to be hoped that when the new subway is laid out past mistakes will be corrected so far as is possible. The adoption of several distributing points, near but not coincident, increases the number of comparatively free lines of traffic and checks the overcrowding that inevitably occurs at a single big terminal. This subject is allied to the matter of routing. If the lines of heavy suburban traffic can be run over routes where the incidental short-distance riding is relatively small, the relief will be at once evident. The same principle applies in the granting of transfers as evidenced in the case of the crosstown lines in New York. Limiting the transfer points is there of great service in relieving downtown lines that otherwise would be even worse congested than now.

It has often been suggested that it would be wise to follow the Continental practice of allowing no more passengers to be taken on than can be provided with seats. So far as the railway companies are concerned it would doubtless serve the end of compelling them to run more cars than at present, but I do not believe that the American public would tolerate it. It must be remembered, however, that during the open-car season the practice is put into effect in various cities, notably in Boston, and it works well. The New York practice of allowing passengers to stand between the seats is utterly indecent and abominable. Here in Boston the public is tolerated to a certain extent on the running boards, but the practice is discouraged and might easily be suppressed. I have already pointed out, however, that the open cars have roughly double the carrying power of the closed ones, so that the latter, unless greatly increased in number, would have to leave behind many passengers if required to seat them.

The no-seat-no-fare scheme is merely a bad method of following the Continental practice. The railways would either have to refuse admission to passengers after the seats were taken, or carry them free. The former alternative is open to the objections already raised, while the latter would produce even more obnoxious crowding than at present. I can imagine no more fitting punishment for the advocates of no-seat-no-fare than to ride in the cars after such a scheme was put in force with the deadhead crowd sitting in their laps and walking over their feet. No, if more cars are needed and can be run to any useful purpose the operating companies should be compelled to run them if they do not do so of their own free will. They have no objection to carrying standing passengers and will continue to do so, but they can be forced to do their level best to provide seats. And the public should stand behind them by regulating other traffic on crowded streets by giving them every reasonable chance for alternative routes and by themselves studying the problem of getting home by the easiest line. Men are to a certain extent like sheep—they will follow a given path almost anywhere rather than go in unwonted lines. Many is the time I have caught an almost empty car after the theatre by the simple process of walking one block down the street, while a hundred people stood on the corner waiting to pounce upon the car when it came along. A choice of routes is often open to a passenger and he should remember that the longest way around is sometimes the shortest way home. Above all, people should learn to discriminate between devices that help both the street railways and the public, and those that merely enforce petty economies, between the impossible and the merely expensive. The holder of a public franchise should be expected to abandon pinch-penny methods, but it should not be forced to attempt the impossible.

### *Electrical Automobile Fire Service.*

Experiments are now being carried on in Berlin with an electrical motor fire service vehicle to carry firemen to the scene of the outbreak. The vehicle carries a reel of hose, ladders, etc., and weighs, when loaded, about 2,200 pounds. It is driven by a four-horse-power electric motor, coupled to the rear axle with double-reduction gear. A battery of accumulators, weighing about 1,200 pounds, furnishes power. A speed of nine and one-half miles per hour can be attained, the motor taking forty-five amperes at eighty-five volts. A second automobile is also being tried in Berlin, which is capable of attaining a speed of twelve and one-half miles per hour. It is driven by two motors, each rated at nine horse-power. The battery weighs 3,300 pounds, and has a capacity of fourteen kilowatt-hours. The vehicle, with the motors, weighs four tons; complete, with battery, firemen and apparatus, seven tons. After a lengthy trial the coefficient of traction was found to be seventy pounds per ton. The cost of running the car twelve and one-half miles is estimated at fifty cents.

## ON ELECTRONS.[1]

BY SIR OLIVER LODGE.

### DETERMINATION OF SPEED AND ELECTRO-CHEMICAL EQUIVALENT OF CATHODE RAYS.

The curvature of path produced in cathode rays by a transverse magnetic field, or the amount of rotation produced by a longitudinal magnetic field, constitutes an evident mode of attacking the problem of estimating their velocity.

If the velocity is constant and the magnetic field uniform, the curve into which the beam is bent will be a circle, and its course can be readily traced either directly, after Crookes manner, by letting it graze a phosphorescent substance, or indirectly by inference from the position of a linear target placed so as to catch the deflected rays.

Consequently there will be no difficulty in determining the radius of curvature, $r$; and the theory is the simplest possible, nothing more than stating that the magnetic force, H, acting on the current element $e\ u$, is the necessary deflecting or centripetal force, $m\ u^2/r$, required to overcome the mechanical inertia of the particles; *i. e.*,

$$\frac{m\ u^2}{r} = \mu\ e\ u\ \mathrm{H},$$

$$\text{whence } \left(\frac{m}{e}\right) u = \mu\ \mathrm{H}\ r;$$

or the ratio $e/m$ is to the velocity of the particles as the curvature of their path is to the intensity of magnetic field which curves it.

The two factors on the right of this equation are directly measureable ($\mu$ being conventionally ignored as usual, or, what is a better mode of expressing it, measuring H as induction-density instead of as intensity of field), but the two factors on the left are both unknown, hence neither can be determined by this means alone; an assumption must be made about one or other of them, or else another independent kind of experiment must be made.

Assume, as many experimenters did, that $u$ is a velocity appropriate to atoms flying in a gas of ordinary temperature, then the value of $e/m$ comes out not so very far discrepant from the usual ionic value measured in liquid electrolysis, *viz.*, $10^4$ c. g. s. Or conversely, assume the usual ionic or electrolytic value for this ratio, and the cathode ray velocity comes out something quite appropriate to atoms of matter.

[1] Abstract of Parts III and IV of paper read before the British Institution of Electrical Engineers. Parts I and II were abstracted in issue of January 31.

This, however, is a trap. These accidental coincidences may retard progress in a most serious manner, for they satisfy the mind and deter people from investigation. It is almost impossible to be completely on guard against them, and they are usually accepted until a more thorough qualitative acquaintance with the subject leads to an instinctive feeling that something is wrong somewhere.

So it was in this case, the long free path and the penetrating power of the cathode rays kept insisting that the particles were not really atoms of ordinary matter, a truth which both Lenard and Crookes had instinctively grasped, in spite of much criticism and valid arguments the other way; so in 1897 J. J. Thomson made a much more serious attack on the position.

He arranged that the magnet should deflect the rays into an insulated hollow vessel, connected with an electrometer and a known capacity, so that the aggregate charge of the cathode ray particles collected in a given time could be measured by the rise of potential observed. He also arranged that inside the hollow vessel they should fall upon a thermal junction of known heat capacity, connected by very thin wires to a galvanometer (acting therefore as a calorimeter), so as to measure their aggregate energy.

Thus he could make the following simultaneous determinations:

$$\mathrm{N}\ e = \mathrm{Q}$$
$$\mathrm{N}\tfrac{1}{2}\ m\ u^2 = \mathrm{W}$$
$$\frac{m}{e}\ u = \mu\ \mathrm{H}\ r$$

In these three equations there are four unknown quantities, but one pair can be treated as a ratio, and another, N, can be eliminated, and thus we get:

$$u = \frac{2\ \mathrm{W}}{\mathrm{Q}\ \mathrm{H}\ r}$$

$$m/e = \frac{\mathrm{Q}}{2\ \mathrm{W}}\left(\mu\ \mathrm{H}\ r\right)^2$$

When these brilliant measurements were actually made in the laboratory the atomic nature of cathode rays was, if not actually disproved, at all events rendered highly improbable; for their speed was found to be of the order 10,000 miles per second, or even as high as one-tenth that of light in a favorable case, being always of the order $10^9$ c. g. s., while the electrochemical equivalent was of the order $10^{-7}$ c. g. s., or about $\frac{1}{1000}$ that of hydrogen.

Changing the kind of residual gas in the tube, and changing the electrodes, made no difference to this last value. The cathode rays were evidently independent of the nature of the matter present, an exceedingly momentous fact. If they were matter at all, they appeared to be matter of some fundamental kind independent of the distinctions of ordinary chemistry. Their velocity, however, depended on the potential difference between the electrodes, in a way that suggested that they were really projectiles urged by the potential gradient acting along a given length of path.

Although the speed of the particles in cathode rays was thus found excessively great, their energy was only moderate, and their aggregate mass therefore excessively minute; their aggregate electric charge, however, was considerable. They were able to raise an electrical capacity of 1.5 microfarads several volts, sometimes as much as twenty volts, in the course of a second; and in the same time they might be able to raise a calorimeter, whose heat capacity was about four milligrammes of water by two degrees centigrade. Nevertheless their mass was so small that it would have taken 100 years to collect a weighable amount, and then only about one-thirtieth part of a milligramme. They traveled with a velocity a hundred thousand times greater than the speed of rifle bullets, and represented the greatest velocity up to that time observed or even now known in matter, if matter they were; and the electrochemical equivalent, instead of coming out in accordance with that observed in liquids, came out some thousand times smaller; that is to say, the charge associated with each particle of the cathode rays seemed a thousand times greater in proportion to the mass than the charge associated with an electrolytic ion, even of hydrogen.

If the flying particles were really atoms, there was no escape from the certainty that they were extraordinarily highly charged atoms; but if, as seemed more likely to the instinct of most of those who worked at the subject, the charge on the flying particles was the same as the charge possessed by an atom in electrolysis, then, assuming that the experiments were correct and correctly interpreted, there would be no escape from the conclusion that the mass associated with the ionic charge in cathode rays must be a thousand times smaller than the mass of a hydrogen atom; in which case the cathode projectiles might conceivably be the detached and hitherto hypothetical individual electrons or atoms of electricity themselves. It would be extremely rash, however, to jump to such a far-reaching conclusion on such comparatively scant evidence. The evidence

must be confirmed by other departments of physics or by other determinations based on a different method, and they must be further scrutinized in the light of the magnetized-radiation phenomenon observed by Professor Zeeman, of Amsterdam.

### DETERMINATION OF ELECTROCHEMICAL EQUIVALENT IN THE CASE OF ELECTRIC LEAKAGE IN ULTRA-VIOLET LIGHT.

The same ratio of $m : e$, or a ratio of quite comparable magnitude, is obtained from phenomena which at first sight appear to be distinct.

One of these phenomena is the effect of ultra-violet light in discharging negative electricity from a clean metal or other surface, a phenomenon the investigation of which was begun by Hertz, and continued especially by Righi and by Elster and Geitel. (See one of the appendices to "Signaling Without Wires," published by the Electrician Company.) If ultra-violet light, whether from a spark or from a flame, falls upon a negatively electrified surface, then in general there will be a leak of electricity from that surface, which electricity can be received by any body placed opposite the illuminated one, and can be used to charge an electrometer of known capacity, and so be measured. Now Elster and Geitel made the notable discovery that the introduction of a magnet affected the rate of leak, according to the direction of its lines of force. This phenomenon suggested a magnetic deflection of the lines of leak, which were shown by Righi to be singularly definite trajectories, and indicated that the leakage was due to the bodily propulsion of negatively electrified particles analogous to the cathode rays.

Two things are necessary to get the particles away from the plate; they must be loosened by the impact of ultra-violet light—the direction of polarization of this light having a very decided influence—and the surface to which they cling must likewise be negatively charged, so as to repel them. Neither light alone nor electrification alone will produce the effect; cooperation is necessary.

J. J. Thomson devised a most ingenious method of carrying out his experiment in a metrical manner, and of deducing from it the electrochemical equivalent of the charged particles, that is to say, the amount of matter which each contained, compared with the electric charge which each carried. To this end he employed the usual arrangement of a small negatively charged zinc plate on which ultra-violet light from a distant arc lamp could shine, through quartz, and also through a parallel piece of wire connected with an electrometer. The distance between the zinc plate and the metallic gauze was variable, and the experiment consisted in observing how much electricity reached the gauze from the negatively charged plate under the influence of light, first without, and then with, a magnetic field of measured strength applied crossways to the region between them.

A little calculation of extreme beauty showed him that the paths of the flying particles under magnetic influence would be cycloids, whose generating circles contained the ratio $m/e$ as well as the ratio $E/H^2$; that is to say, their trajectory, if it could be observed, would involve the electrochemical equivalent required and likewise the ratio of the electric to the magnetic field applied, as well as the absolute strength of the magnetic field.

There is no known way of actually observing this quite invisible and purely theoretical trajectory; but when it is perceived that in accordance with this theory all the particles moving between the plates will have similar paths, so far as they do not come near the edge of either plate—in which case they would not be propelled so far—it becomes plain that there should be a critical distance within which the gauze would receive and intercept all the particles, and beyond which not a single one would be able to reach it.

The sharpness of actual experimental observation of the critical distance was not found quite so great as this simple theory would indicate, because of disturbing causes, one of which was the presence of some residual air, interfering with the perfectly free path of the moving bodies; nevertheless it was sharp enough for fair determination; and the result was again, in this case also, that the ratio $e/m$ came out $10^7$ c. g. s., or more exactly $7 \times 10^6$; corresponding closely with the values found by J. J. Thomson, confirmed subsequently both by Lenard and Kaufmann, for the cathode ray particles.

The only things which give the ordinary electrolytic value for this ratio are the positive carriers. These are not so easy to observe, but Wien[1] has examined these by detecting and measuring the slight magnetic deflection exhibited by certain rays behind the cathode in a vacuum tube, which Goldstein discovered and called Kanal-strahlen, and which Ewers proved were carriers of positive electricity. Wien has shown that they move slowly, and that in hydrogen their ratio $e/m$ is of the order $10^4$, that is to say, the proper value for a hydrogen atom or ion, and with other substances the ratio has been found to vary with the substance and approximately to equal the electrolytic value, for these positively charged particles. J. J. Thomson has likewise made measurements on the positive carriers by means of the discharge from incandescent filaments and other positively charged hot bodies, and has confirmed Wien's results.

Thus it is forcibly suggested that whereas the positive carriers of electricity are *ions*, consisting of a unit + charge associated with an atom, the negative carriers appear to be dissociated from the main bulk of the atom, as if they were only fractions or fragments or constituents or appendages of an atom, which, detached and flying loose, are able to attain to prodigious speed; since any acceleration to which they are subjected is a thousandfold greater than it is even for an atom of hydrogen, weighted down and burdened as that is with a mass of inert material and subject only to the very same propulsive force.

Think of the mobility of a set of particles which experienced the usual gravitation intensity $g$ and had only one one-thousandth of the mass to carry. There is no known way of thus intensifying gravity; there are plenty of ways of diluting it, *e. g.*, Atwood's machine, an inclined plane, etc. But such a mobile particle as that we are now considering would drop under the influence of gravity not sixteen feet in the first second, as everything we know does near the surface of the earth, but 16,000 feet, or about three miles, and would in one second acquire under gravity a velocity of six miles per second, enough almost to carry it out of the range of the earth's attraction altogether, and more than enough to carry it around the world.

The acceleration to which such particles are subject in a vacuum tube is far greater even than this, because there the forces are so prodigious; gravitation force on ions is almost infinitesimal compared with common electrical force on their charges.

Thus the hypothesis becomes more and more justified that these units of electric charge can separately exist; perhaps carrying with them part of the atom, in which case they might be called corpuscles, having a material nucleus, perhaps pure disembodied electricity, whatever that may be—an electrical charge detached from matter—in which case they would correspond with those hypothetical entities familiar in theoretical and mathematical treatment as "electrons."

[1] *Wied. Ann.* lxv, p. 440. See also Ewers in *Wied. Ann.* lxix, p. 187.

THE ELECTRON THEORY OF CONDUCTION AND OF RADIATION.

Meanwhile the probability of the existence of electrons and the possibility of regarding them as the basis of all electric and of most other material phenomena had seized hold of the imagination of several mathematical physicists, notably of Dr. J. Larmor and of Professor H. A. Lorentz. Both these philosophers endeavored to trace all electric properties to the behavior of electrons, usually, of course, in association with material atoms; and Dr. Larmor proceeded to try and invent a possible structure in the ether which would have the properties of an electron, whether positive or negative, and so reduce a great part of physics to its simplest terms. This magnificent attempt at a new principia has not yet been finally successful, but a great mass of very suggestive material is to be found in Dr. Larmor's contributions to the transactions of the Royal Society, and in his recent great summary called "ether and matter," which last, published by the Cambridge University Press as an Adams prize essay, is accessible, though barely intelligible, to all.

Suffice it here to say that the electron constitutes the basis of the whole treatment, and that there is supposed to be no electric current except electrons in motion. They may move with the atoms, as in electrolysis; they may fly alone, as in gases, or they may be handed on from one fixed atom to the next, as in solids.

CONDUCTION.

The possible modes of conduction or transmission of electricity are in fact three, which I may call respectively the bird-seed method, the bullet method and the fire-bucket method.

The bird-seed method is adopted in liquids, it is exemplified in electrolysis; the bird carries the seed with it, and only drops it when it reaches an electrode.

The bullet method is the method in gases, as has been clearly realized by aid of the cathode rays, the space from cathode to anode represents the length between the breech and the muzzle of the gun, and the rest of the path is analogous to the trajectory of a bullet, which ultimately either penetrates or is stopped by a target, with a flash of light or other appropriate disturbance.

The fire-bucket method must be the method of conduction in solids, where the atoms are not susceptible of locomotion and can only pass electrons on from hand to hand; oscillating a little in one direction to receive them, and in another direction to deliver them up, and so getting thrown gradually into the state of vibration which we call heat. But it may be observed that this need for motion, in order to pass electrons on, becomes less and less according as the body is less subject to the irregular molecular disturbance we call heat.

Metals are bodies in which the transfer of an electron from one atom to another is easy, demanding no force as long as the process is not hurried—a process of the nature of a diffusion; insulators are bodies in which it can only be accomplished with violence. The transmission of vibrations along a chain of connected molecules may well occur through a not dissimilar kind of connection; and hence the conduction of electricity and the conduction of heat, though really different processes, may have many points in common.

Most is known about electrolytic and gaseous conduction. In gaseous conduction the negative electrons fly free and fast; the positive charges travel slowly by reason of their association with matter.

In liquid conduction both sets of electrons are associated with atoms, and travel only as ions at a slow diffusion rate which was calculated by Kohlrausch, has been observed by myself and others, and is well known.

The rate of transmission in solids can only be inferred, and it would appear as in one class of solids the positive were able to travel fastest, whereas in another class negative traveled fastest, a difference which is familiar in liquids. In acids, for instance, the positive charges travel much the quickest, because they are associated with light hydrogen atoms, and it is owing to the comparatively easy migration of this light or small hydrogen atom that acids are in general such good conductors.

The Hall magnetic bend, like Faraday's magnetic rotation, is a differential effect, and would be zero if positive and negative were equally acted on. In gases it is differential too, but there the negative charges are so free as compared with the positive, and fly so much more rapidly, that the Hall effect in gases, especially in rarified gases, is very great in comparison with the small residual effects found in liquids and solids.

RADIATION.

But it is not only the progressive motion or locomotion of the electric atomic appendages that we have to consider; we must assume also that they are susceptible of motion in the atom itself, either vibrating like the bead of a kaleidophone, or revolving in a minute orbit like an atomic satellite. Indeed it is to the vibrations or revolutions of the electrons in an atom that its radiating power is due. Matter alone has no perceptible connection with the ether,[1] it is electric charge which gives it any connection, and even then it has no viscous connection—there is no connection that depends upon velocity, or is of the nature of friction[2]—it is purely accelerative connection; it is only when the charge vibrates, and during its accelerative periods, that it is able to influence the ether and carve it into waves[3]—waves consisting probably of alternations of shear, with no motion of the ether as a whole, but only a to-and-fro quiver of its equal opposite constituents over some excessively small amplitude, a kind of motion which constitutes what we know as radiation. It is not the atom pulsating as a whole which disturbs the ether, but the pulsations or vibrations, or the starting and stoppings and revolutions, of its electric charge. But normal or centripetal acceleration, involving nothing more than change of direction, is just as effective as actual change of speed. If an electric charge is able to describe a small orbit four-hundred-billion times a second, it will emit the lowest kind of visible red light. If it vibrates faster it will emit light of higher refrangibility, and the particular kind of radiation emitted by the atom of any substance, when in a fairly free state, will depend on the orbital period of its electrons, every frequency of vibration corresponding to a definite line in the spectrum.

But, if this be so, radiation must be susceptible to magnetic influence, for a revolving electric charge constitutes a circular current, and if a magnetic field is started into existence with its lines threading that circuit, it must, while it is changing in intensity, cause the speed either to increase or to decrease, and so will either raise or lower the refrangibility. If, then, electrons are revolving in every direction and a magnetic field is excited, during the rise of the field the pace of some will be increased and of some decreased, and this increase or decrease will not stop until the magnetic field is destroyed again.

Hence it would appear that if a source of radiation is put into a magnetic field, and its lines examined with a spectroscope, they should be doubled, some being raised in refrangibility, others

[1] Lodge, *Phil. Trans.*, vol. clxxxiv, pp. 727-804, and vol. clxxxix, pp. 149-166.

[2] See especially *Phil. Trans.*, vol. clxxxix, p. 164.

[3] See Part I of this paper, also Appendix G.

lowered; or if any are left unaltered the line might be tripled, or if the motion was of a more complicated character the line might conceivably be quadrupled or sextupled, or any other change produced according to the character and complexity of the motion. At any rate it would seem that the line must be affected somehow, even if it were only broadened. It happened, however, that when Dr. Larmor theoretically perceived this, and did the calculation for it in 1895, to see how much effect might be expected, he made the natural assumption not that an electron could move by itself on a comparatively stationary atom, as above described, but that the atom was itself pulsating or revolving or quivering in some way as a whole and carrying its charge with it. On this assumption, knowing what he did about the massiveness of an atom, he perceived that the effect would be too small to see, and inasmuch as Faraday had, with imperfect appliances many years ago, looked for some such effect—not then guided by theory, but simply with the object of trying all manner of experiments—and had failed to see anything, no fresh experimental attempt to examine the question was initiated, nor was the matter publicly referred to until, as hinted above, Zeeman, of Amsterdam, in 1897, with a powerful Rowland grating and a strong electromagnet, skilfully observed a minute effect consisting in a broadening of the lines emitted by a sodium flame placed between its poles.

From this simple but important beginning the large subject of the influence of a magnetic field on the radiation from different substances has been laboriously worked at, not only by the original discoverer, but by Preston in Dublin, Michelson in America, and others; and a whole series of important facts has been made out. Every line has been studied separately; some lines are quadrupled, some tripled, some sextupled, and so on, as said above. One mercury line is resolved into as many as eleven components. The effect is therefore not too small to see, though it needs excessively high power and perfect appliances to see it; and so it became evident that if radiation were due to moving electrons, their motion could not be handicapped by having very much matter associated and moving with them. It became possible, indeed, by making a measurement of the amount of doubling undergone by the lines in a given field, to ascertain how much matter was associated with the revolving electric charge in any given case; in other words, to make a determination of the electrochemical equivalent effective in radiation, *i. e.*, of the ratio $m/e$. Indeed, Professor Zeeman, with considerable skill, made a rough determination of this kind at a very early stage, when he only saw the effect as a slight broadening of the sodium lines, and came to the conclusion that the electrochemical equivalent was quite different from that appropriate to electrolysis, being some thousand times smaller. He found, in fact, that the ratio $e/m$ had in this case also the notable value already suspected in connection with cathode rays, *viz.*, the value $10^7$ c. g. s.

More recent measurements have confirmed this estimate, and shown that the ratio of charge to matter in the Zeeman case is practically identical with the ratio of charge to matter in the cathode ray case; in other words, that whatever is flying in the cathode rays is vibrating in a source of radiation, and that if the cathode rays consist of moving electrons, radiation is due to vibrating or revolving electrons.

Even this, however, does not constitute a proof of the existence of masses so much less than atoms; it may be only a remarkable coincidence. Besides, it is possible that in all these cases the whole atom is, after all, moving, but that its electric charge is 1,000 times bigger than what had previously been observed as the proper charge of an atom.

But this assumption, improbable even for the cathode rays, becomes still more unlikely in the case of radiation, where it is not at all unnatural that only a very small part of the atom should be moving, the great bulk of it being practically stationary. Besides, the more the details of the Zeeman effect are studied, the clearer it becomes that the electron theory attributed to it from the first by Professor H. A. Lorentz, as well as by Fitzgerald and Larmor, in England, is complete and satisfactory.

### ON THE ELECTRON THEORY OF THE MAGNETIZATION OF LIGHT.

Among the early contributions that have been made to the theory of moving charges, few are more remarkable than those of Dr. Johnstone Stoney in connection with the process of radiation, long before there had been any experimental verification of the separate existence of these electrons, or of the fact that the emission of light from a substance is due to their motion. Dr. Stoney had treated them in an astronomical manner, in 1891, dealing with an electron moving round an atom as if it were a satellite moving round a planet, and had discussed the various perturbations to which they might be subject, and the effect of those perturbations on the spectrum of the light emitted.

One of the simplest kinds of perturbation is what is called a progression or recession of the apses, being a slow revolution of the orbit in its own plane. Such a motion was shown to be able to account for a doublet in the spectrum, for of the two component vibrations into which the motion can be analyzed, one has been made more rapid and therefore its light raised in refrangibility, the other has been made slower and therefore lowered in refrangibility.

Another close allied kind of perturbation, analogous to precession of the equinoxes in the case of the earth, would result in a line triplet in the spectrum. This precessional motion occurs in an orbit subject to any oblique pull or deflecting force. Instead of yielding directly to that pull, its effect is to make the axis describe a kind of cone, the kind of motion that one sees in an inclined spinning top; the pull of gravity on a spinning top does not make it topple over, but makes it precess. So also with a hoop or bicycle when not vertical, instead of tumbling, it turns round and round in a circuit as long as its motion continues, only falling when the motion ceases. Hence if the orbit of an electron were subjected to an oblique or deflecting force, the effect would be not to place it directly in the desired position perpendicular to a line of force, but to cause it to precess; and this motion might be analyzed into three, the acceleration and retardation of circular orbit above-mentioned, which would result in a doubling of the line, and a third component, *viz.*, the one parallel to the axis which would be unchanged, and would therefore represent a spectral line in its old position, the centre of the group of three. All this was clearly perceived by Larmor and Fitzgerald in connection with Dr. Zeeman's discovery, though they were anticipated by his great compatriot the eminent physicist, H. A. Lorentz, to whom the most complete publication of the theory is due, being in several respects anticipatory of the experimental results. For it may be observed that the light emitted by the oscillation components above spoken of will be all of one definite kind, due to vibrations in one definite direction and therefore polarized. The kind of polarization would depend on the aspect from which it was seen. If seen at right angles to the axis of precession, all three lines should be plane polarized, the middle line at right angles to the other two. If, however, it be looked at along the axis of precession, then there should be no middle line, because the axial vibration would then be end on, and the two side lines should be circularly polarized.

Directly, Zeeman had demonstrated the fact that a magnetic field applied to a source of light was able to act as a perceptible perturbing cause, Professor Lorentz was at once able to predict the whole of that which has been here stated about the tripling of the line seen sideways to the lines of force, and the doubling of the line seen endways, with all the polarizations as just stated, because the lines of magnetic force constitute the precessional axis. And all these effects were shortly afterward seen by Zeeman and others, and are characteristic of the simplest circular orbit. In fact it is hardly too much to say that the discovery of Zeeman, in the light of the theory of Lorentz, has doubled the power of spectrum analysis to throw light upon the processes of radiation and the properties of atoms, and has opened up a new department, as it were, of atomic astronomy with atoms and electrons instead of planets and satellites.

## AN ELECTRICAL RIVER GAUGE.

BY J. F. BARNES.

One of the duties of the United States Hydrographic Survey is to observe and record the flow of water in all the principal rivers of the country. Several methods have been used for this, the one selected in each case being dependent upon the importance of the stream and its character. In general, these methods have necessitated the presence of an observer to take the readings and keep the records of the station. Readings were therefore taken one or more times during the day, at stated periods, and from these values the yearly flow of the stream is computed. In securing records of freshets and sudden storms, much depended upon the zeal of the observer and his other duties.

Recognizing from his own experience the need of an automatic recording river gauge, Mr. Weston M. Fulton, weather observer at Knoxville, Tenn., has developed a very simple apparatus which has been in successful operation for some time past. The construction and action of this will be clear from the following description:

The mechanism of the part shown on the right of the illustration, which is located at the river, consists of two pulleys and a small gear-wheel mounted upon one shaft. Around the larger pulley is wound the wire supporting the float. Around the smaller pulley—which can just be seen back of the other—is wound the wire supporting the counterweight. Both pulleys are grooved, and the shaft is threaded so that the wires wind and unwind, the point of support retains the same vertical position. The small gear engages in a pinion of sufficient length to allow full longitudinal play to the shaft. This pinion, through a second gear, drives a small shaft, as shown in the illustration, the gear ratio being such that this shaft makes one revolution for every one-tenth of a foot motion of the float. From each end of this small shaft is loosely suspended a bar about three inches in length with a crescent-shaped cam attached to its face near the point of suspension. There is also attached to this shaft a T-shaped lever, at each end of which, but on opposite sides of the T-head, are light metal springs. As this lever revolves, it passes between the two bars mentioned above.

At this moment one of the springs, having no support behind it, will bend back, and thus pass the rod. The other, however, being on the other side of the T-shaped lever, will be pressed against this and, thus supported, will be sufficiently stiff to raise the rod at that end for a slight distance. A point is soon reached where the metal spring can no longer support the weight of the lever, which then falls back to its original position. In so doing, its crescent-shaped cam presses down the end of one of the two projecting springs shown, supported on the posts at the left of this mechanism. To this spring is attached a small platinum wire which, when the spring is depressed, enters a mercury cup fastened to the base, and thus closes an electric circuit. It will be seen from this that as the float which measures the height of the water rises, the two pulleys and the gear train revolve in one direction, driving the small shaft and making a series of contacts at one of the two mercury cups. As the float falls with the water, the contacts are made at the other cup.

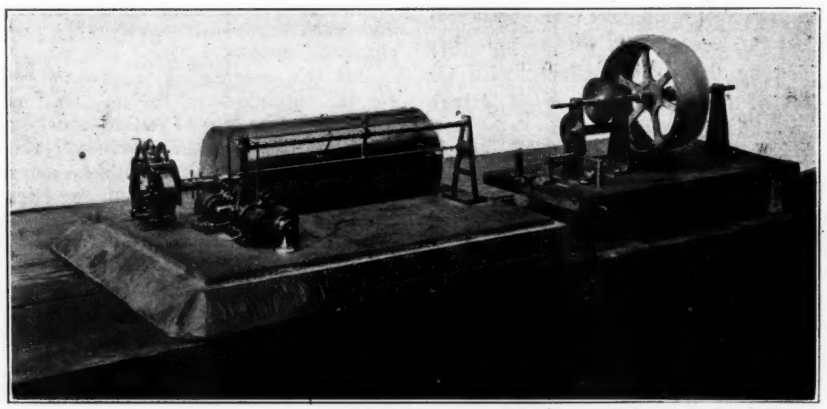
The float moves in an iron casing, which is attached to the face of a bridge pier, and which has its lower end below the surface of the water in the river. The counterpoise is suspended inside of a short iron pipe to prevent interference with the apparatus.

The recording apparatus shown in the left of the illustration consists of a drum, around which the paper to receive the record is wound; a clock mechanism for driving this drum at a uniform speed, and two relays operating rachets, which, in turn, turn the spirally grooved shaft seen in the illustration and thus shift the recording pen. The lower rod, parallel to the spirally grooved shaft, is merely a guide to prevent the pen turning over with the shaft.

The operation is as follows: When contact is made at either one of the two mercury cups, as described above, this completes a circuit through one of the two relays, which attracts its armature, and thus, by means of the vertical rod and a pawl, shifts the grooved shaft through one notch. The other relay, which is placed on the other side of the support for the grooved shaft, operates in a similar manner, but turns the shaft in the opposite direction. The two pawls are so constructed that they act in a manner similar to a clock escapement, and thus avoid all possibility of moving the rachets more than one tooth at a time. The motion of these ratchets, of course, shifts the pen along the drum, and in this way records all movements of the float.

To operate the gauge, three wires are carried from the apparatus at the river to the recording gauge, which may be placed at any convenient point. At the river these wires connect, one to the two binding-posts attached to the bottom of the mercury cups, and one each to the two contact springs.

The Knoxville weather bureau office is nearly a mile from the river. Here the recording apparatus is placed. Upon the drum is wound a record sheet as often as may be necessary, and these sheets keep a continuous record of all the fluctuations of the river. It is particularly valuable in securing data of freshets or other sudden rises of the stream.



AN ELECTRICAL RIVER GAUGE.

Mr. Fulton, who is also professor of meteorology of the University of Tennessee, has turned over his invention to the government. Many of these will be installed in weather bureaus all over the country, for securing more complete data of river flow. They can also be used for tide gauges at the coast stations.

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The air resistance to the rotation of a flywheel may cause a considerable loss of energy. A 450-horse-power engine, direct-connected to a generator, has a flywheel with channel-shaped arms. The tests were made by using the generator as a motor, driving the flywheel up to a normal speed. It required 13,300 watts to rotate the wheel and shaft, but by enclosing the arms in a sheet-iron casing the wheel was driven by an expenditure of 9,874 watts. The saving effected by use of the shield was 5.7 horse-power, or 1.2 per cent of the power of the engine.

## THE DESIGNING OF TELEPHONE APPARATUS—XVII.

BY W. A. TAYLOR.

### THE RELAY.

With multiple switchboards and especially common battery or central energy systems the use of the relays is essential. These relays are electromagnetic mechanisms, so arranged in the circuit that they automatically close or open some local circuit.

There are three classes of relays: 1. Those which are operated from the subscriber's station. 2. Those which operate on a local circuit independent of the line. 3. Those which are connected in the bus wire of signals and made to operate whenever a signal is to be operated. In the first class are the line relay or the relay which operates the line signal, also certain supervisory or clearing out relays.

In the second class belong cut-off relays or those relays which operate when the plug is inserted into the jack. These disconnect the line signal and in some systems throw the busy test on the multiple jacks. To this class belong certain auxiliary relays which assist in the action of the supervisory lamp system.

The third class are the pilot relays which operate pilot lamps, night bells and monitors' signals.

This kind of relay is most numerous and in central-battery systems almost any problem may be solved by the use of some kind of relay. Almost any switching combination may be accomplished by its use. It must be remembered, however, that in designing a circuit it is well to work toward simplicity. While adding relays and other apparatus may effectually produce the proper results in the laboratory or where skilled help is employed to take care of the work; it must be remembered that nine-tenths of the telephone employés who will take care of the apparatus are not competent to attend to complicated systems. In addition to this, the system must be simple in order that the manufacturer may make sales in competition with other designs.

### THE LINE RELAY.

This relay is usually with simple winding. The size should be great enough to permit of a sufficiently great number of turns of wire. The winding must be of wire sufficiently large and resistance high enough to stand indefinitely the current from the battery when the line is short-circuited. The carrying capacity of the wire should be great enough so that it will stand for about ten minutes sufficient current to open the protecting fuse or heat coil on the line. As these heat coils in central-energy work are supposed to carry one-fourth ampere indefinitely, some idea of the size of the wire may be gained. If not of this capacity any foreign current will burn out the coil before the protecting apparatus acts. This point was overlooked by at least one prominent

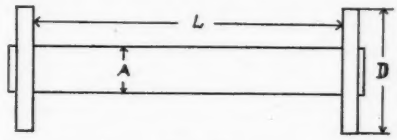



FIG. 48.

manufacturer in several very large exchanges; he was not blamed however—the man who furnished the protective apparatus got the credit (?) for turning out poor material.

The size of spool for the winding of a line relay should not be less than the following dimensions to produce the best results. See Fig. 48. L, the total length of winding two and one-half inches. A, diameter of core three-eighths inch. D, diameter of head one inch. The winding should not fill the spool, however, but should come within one-sixteenth of an inch of it. That would make the diameter of winding seven-eighths of an inch. With such a coil, wound to 250 or 300 ohms, a positive signal may be given

FIG. 49.

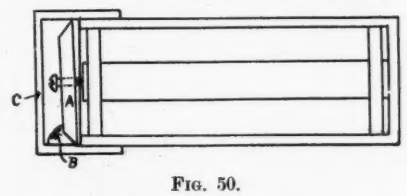



FIG. 50.

over the longest line practicable for central-energy systems. Of course there are systems which require much lower wound coils for the line or lamp relay, and in these the winding space must be larger in order to permit of a sufficient number of turns of wire to operate properly. A good test for a line relay is to operate positively through 750 ohms external resistance with the voltage of the battery necessary for operating the system. This will be equivalent to a very long exchange line. For positive operation a margin of twenty-five per cent under the limit is allowed.

The mechanical design of a relay, as well as the magnetic condition, has a great deal to do with its sensitiveness. In Fig. 49 the core of the spools is continued in a bent yoke piece, Y. The armature, A, is attached to the front of this yoke and merely tilts up when the magnet is excited. The tilting of the armature raises the spring, B, into contact with spring, C, breaking contact with spring, D. It is obvious that almost any combination of springs may be used, from one set to three or four, with either top, bottom, or both top and bottom contacts. This is the most flexible type of relay, because any desirable combination may be made without any change in the design or any extra expense for the manufacturing of tools; E, is a rubber rest which stands upon the iron yoke, Y, and passes through to springs B and D. The tension of the spring D is downward so as to hold E in position. The hole in B is large enough to permit free movement of the spring. C presses upon the end of E, and is held by it so as to prevent accidental contact with B. The function of E is to hold the springs in a uniform position with respect to each other. To make this type of relay more sensitive a brass or copper rivet should be placed in the armature at the point, F, to prevent it from touching the yoke. When touching the yoke there is a tendency to stick at the start unless operated rather strongly. This, as well as all types of up-to-date relays, should have the contacts protected from dust. The most approved method is to enclose the whole mechanism in a tube. This tube acts as a shield to prevent cross-talk where the relay is not cut out of the talking circuit when in use. The tube, T, Fig. 49, is usually made to screw on a disc, P, making the whole almost absolutely dust-proof.

Fig. 50 shows another form of relay used by the Bell companies for a number of years. This is of the tubular form with a single contact made on a point at the end of the core. The armature A is a copper-plated bevel edge iron disc. It is beveled so as to give a knife edge to swing on and also to throw the weight back of the supporting point in order that it will fall back by gravity when released. It is evident that this relay will operate properly only in a horizontal position. The copper-plating on the armature is to prevent sticking. These relays gave trouble because of the uncertain contact between the edge of the armature and the cap C. To get around this difficulty a small spiral of wire, B, was connected to the armature and to the frame of the relay. This is a very sensitive piece of apparatus, but lacks the flexibility of the former type.

# *Pacific Cable Notes.*

*By Lewis G. Martin.*

A PLEASANT and instructive run across the great continent of North America, a beautiful voyage on the Pacific Ocean, work which was full of interest from beginning to end, the making of new and esteemed friends, is, in a few words, the history of the laying of the land cables which connect the first section of the transpacific cable from the seashore at Honolulu and San Francisco to the offices of the cable company at those places.

The cables, three in number—two for Honolulu and one for San Francisco—which were manufactured by the Okonite Company, Limited, of New York, to the specification of the Commercial Pacific Cable Company, are as follows: Each cable consists of four cores laid up around a jute centre, having a full twist every ten feet, then covered with jute and lead. Each conductor consists of seven wires, stranded, weighing approximately 170 pounds to the mile, and covered with "Okonite" to a diameter of 0.295 of an inch. Each of the cores is taped and lead covered, and on three of them there are distinguishing marks in the shape of raised ribs, the fourth one being left plain. The cores were subjected to a breakdown test of 5,000 volts alternating current, applied for ten minutes, and tests for insulation, conductor resistance and capacity were constantly taken during manufacture and laying. After the cables were laid and spliced up, final tests gave results practically identically the same as those obtained at the factory without splices, namely, insulation, 4,357 megohms per mile; conductor resistance, five ohms per mile, and capacity, 0.415 microfarad per mile.

There was considerable excitement on Market street, San Francisco, in front of the Postal Telegraph Company's main office, on Monday, November 3, and an ever-increasing crowd was wondering the why and the wherefore, when Mr. Storrer, the general superintendent of the California division of the Postal Telegraph-Cable Company, brought out and tacked on the reel of cable set up for pulling in, a placard which read, "Commercial Pacific Cable Company, Honolulu Section."

"Oh," exclaimed the crowd, in almost one voice, "so this is the commencement of the great American Pacific cable we have heard so much about." One gentleman remarked he was glad to be on hand to see the start, for he had been much worried to know how on earth the company was ever going to get that iron wire —the leading wire left in the pipe to haul the pulling rope through with—to work, since it must be grounded where it touched the iron pipe, which was, of course, from end to end of the conduit. Another gentleman wondered which of the cable hands crawled through the pipe with the wire!

Monday, November 3, will go down into history as the day on which the first portion of the all-American transpacific cable was laid. The cable is laid in a three-inch wrought-iron pipe, with manholes inside, and cast-iron boxes outside of the city limits about 434 feet apart. It was the wish of the company that the cable should contain as few splices as possible, and it was left to my judgment to decide in just how long lengths it should be pulled in. After calculating the weight, amount of friction to be overcome, and breaking strain, I decided to pull in in quarter of a mile lengths, and this was done throughout without a hitch of any kind or damaging one inch of the cable.

THE CEREMONIES ATTENDING THE LAYING OF THE SAN FRANCISCO END OF THE NEW PACIFIC CABLE; GOVERNOR HENRY T. GAGE AND MRS. GAGE AND DAUGHTER, LUCILE, IN THE FOREGROUND; MR. W. H. BAKER ON THE GOVERNOR'S LEFT; MR. GEORGE GRAY WARD IN THE CENTRE; IMMEDIATELY ON HIS RIGHT ARE EDGAR C. BRADLEY AND AMASA P. FLAGLER.

As before stated, work was commenced on November 3, and by November 19 the cable was taken into the cable house, near the Cliff House, and communication established between there and the office.

We were delayed two days, as a portion of the pipe line was not quite ready for us, so that the cable was laid in fifteen actual working days. Tests were taken nightly of the completed lengths, and gave uniform results throughout.

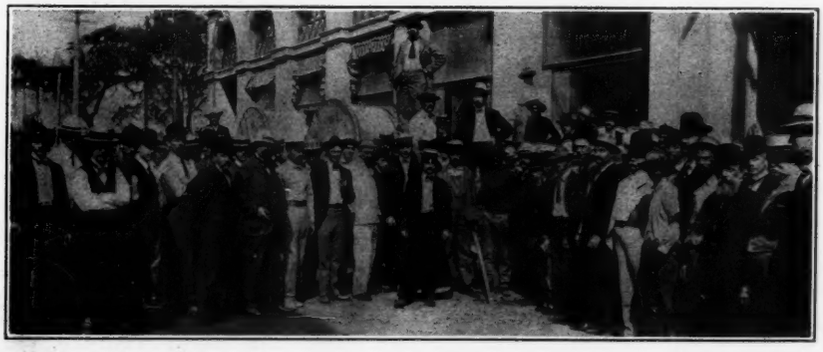
The cable being completed in San Francisco, tools and materials were packed up,

and on Thanksgiving day, November 27, I sailed in the steamship Ventura, with two cable hands and two splicers, for Honolulu, of which I heard much but knew little. The trip was uneventful, but as soon as my mission was known, my Hawaiian fellow passengers plied me with numerous questions, such as the following: "When did I expect the cable to be completed and opened for business?" "How much a word would it be?" "How long would it take to lay the submarine portion?" "When was the ship expected at San Francisco?" "How long would my work take?" and "Why the cable I was to lay looked like lead pipe?" etc., etc., etc., all of which I of course replied to as best I could.

On December 3, about 1 P. M., land was sighted. It was the island of Molokai, on which stands the famous leper settlement.

Molokai is about fifty miles from Honolulu, and after a run between the islands of Molokai and Oahu, which was full of surprises every few hundred feet, as different beautiful views of land and water opened up, the good ship Ventura was finally docked at 6.30 P. M.

I had been advised to make my headquarters at the Royal Hawaiian Hotel, and had not been there many minutes before I was besieged by newspaper men and contractors, the former anxious for news and the latter for business, all of whom were given as much information and satisfaction as was possible under the circumstances. I found the newspaper men of the island exceedingly courteous and considerate. If my friend, Mr. Boyd, should see this, I hope he will make a note of it and accept my "aloha."



Laying the Shore End at Honolulu, H. I. The Cable Gang, Splicers and Spectators; Mr. L. G. Martin in the Centre.

December 4 was taken up in preliminaries, and on the morning of December 5, work was commenced from the office of the Commercial Pacific Cable Company in the Young Building.

If we had an excited and curious crowd at the start in San Francisco, I hardly know what to say of the intensely interested crowd that watched the getting-ready process for the start in Honolulu. Cables are plentiful in and about San Francisco, but here was something the like of which had probably never been seen before by nine-tenths of the onlookers; and what puzzled them most was its similarity in appearance to a lead pipe, and I was so afraid that curiosity would get the better of some of the more ambitious, to the extent of driving a hole in the lead to see what would run out, that I stationed a man to keep the crowd at a safe distance.

Well, the first cut in the cable was a revelation, and the questions asked as to what the bright wires were for, why there were four of them, and what the black stuff "Okonite" was, would fill a whole year's Electrical Review. However, suitable replies were given, and I think all went away satisfied.

Of course, specimens were in great demand and many were given away, to the delight of the recipients.

Interest in our work was maintained throughout, and at all times a wondering crowd could be seen watching the cable gang and splicers.

Naturally, being in Hawaii, we had to do as the Hawaiians did, and it was not

The Cable-Laying Ship "Silvertown" in San Francisco Harbor.

long before we were referring to the native ladies as "wahine," verandas as "lanai," and instead of the foreman shouting "all through," he simply said "pau." Using native terms of course increased our popularity.

By December 19 the cables were in from office to cable house, and the splicing was completed on the twenty-second, final tests giving eminently satisfactory results.

The two cables in Honolulu are each 5.0445 miles in length, and that in San Francisco 6.456 miles, and for the information of those familiar with the two places, the route followed is: Honolulu, King street to Alakea street, to Queen street, to Ward avenue, to Beach road, to Kalai road, to Waikiki road, to Main avenue, to Sans Souci, where the cable house stands; San Francisco, Market street to Geary street, to Point Lobos avenue, to Forty-seventh avenue and the cable house.

On December 26 the cable-ship arrived, and the excitement was intense. Steamship and factory whistles were blown, and a half-holiday in all the public institutions declared. Three steamers went out

to escort her in, one carrying the native band, which played for the first time the "Pacific Cable March," composed by the bandmaster, and a creditable piece of work as far as the music goes, but somewhat disappointing in the words, which consist, in the main, of "the cable is here."

As soon as she docked, I went on board and met old and made new friends, and learned from them that the trip had been a nerve-racking one for all on board. Bad weather was encountered throughout the greater part of the voyage, and there were times when it was a serious question as to whether it was advisable to continue or "cut and run."

However, the superior skill of those responsible for the safety of the cable, saved the situation, and it was finally buoyed in sight of the islands.

As the cable went overboard and the ship as a result got lighter, the difficulties increased, and when on entering the Molokai Channel on the morning of December 26, the ship rolled to the extent of forty-two degrees and thick weather obscured the land, it was decided to cut the cable and buoy it, and proceed to the harbor to await more favorable conditions.

Great disappointment was felt because the ship had to cut the cable, but it did not last long when the people were convinced it would be an easy matter to "put through" as soon as the storm subsided.

The heavy shore end was laid on Sunday, December 28, amid great enthusiasm and suitable celebration, and on the morning of December 29 the ship buoyed this end up and went down to the deep-sea buoy to see if the weather was favorable for picking up and splicing on, and finding it was not, returned to the harbor.

On January 1, the weather having been gradually moderating for two days, the ship again went out, picked up the shore end, spliced on, proceeded to the deep-sea buoy, and at 4 P. M. told Honolulu the final splice was about to be commenced, and to call San Francisco at nine o'clock. It was not long before this news got abroad, and at nine o'clock the cable house looked more like the entrance of a theatre on a first night's appearance of some celebrated actor or actress in some celebrated play.

Congratulatory telegrams began to pour in, the first to pass over the cable being that from the secretary of the islands to President Roosevelt, and as soon as it was known that this had gone, and it was realized that cable communication with the mainland was at last an accomplished fact, the crowd cheered itself hoarse, and everybody wanted to shake hands with everybody else.

The writer of this article had the honor of sitting at the key and sending the first press despatch which passed over the cable. It was a message filed by E. D. Moore, special press representative who accompanied the expedition to the Associated Press, giving an account of the voyage and proceedings at Honolulu.

January 2 was given up to rejoicing. In the afternoon public addresses were made in the grounds of the late king's palace, now the executive building, and congratulatory telegrams read to the immense gathering of people from all parts of the islands. In the evening a public ball was given in the executive building, which was largely attended, and, judging by the expression on the faces of many of those present, very much enjoyed.

The trip was full of interest from beginning to end, and to the many friends, electrical and other, I am indebted for many courtesies which helped to make my work easy and my visit pleasant.

This account would not be complete without an acknowledgment of valuable assistance received from Charles Cuttriss, electrician of the Commercial Cable Company; H. F. Harrington, superintendent of the Commercial Pacific Cable Company, at San Francisco; J. D. Gaines, superintendent of the same company at Honolulu; S. S. Dickinson, the company's general representative, and Louis Glass, vice-president and general manager, and Frank Quinn, superintendent of supplies of the Pacific States Telegraph and Telephone Company, San Francisco.

## *An Egyptian Electric Traction System.*

The Alexandria & Remleh Railway Company and the Alexandria Tramway Company are changing their lines to an electric traction system. The work is now well advanced. When completed, trains consisting of two carriages will run at ten-minute intervals. The cars will be large and handsomely finished, with seats for sixty-four passengers. The power-house will contain two compound engines of 1,000 horse-power each, driving two 600-kilowatt, three-phase generators, yielding current at a pressure of 6,500 volts. Power will be transmitted over a high-tension line to a substation, where it will be stepped down by transformers and changed by converters to continuous current at 500 volts.

## *New York Electrical Society.*

The 231st meeting of the New York Electrical Society was held on January 29 in the new waterside station of the New York Edison Company. The arrangements for the disposal of the guests were so admirably made that each of the visitors, placed in charge of a special guide, was able to cover all the salient points of the station.

At the close of the inspection a supper was given to the members of the society, and a vote of thanks was tendered to the company for its courtesy and hospitality. The evening was one of great enjoyment and success.

The following members were elected: Harold D. Patterson, Richard H. Johnston, Andrew Moss, Almon B. Fuller, Wm. Edw. Hurley, Wm. Taylor, Robert Chas. Cole, Joseph Burkart, F. L. Sheffey, Ralph Ryder, Chas. F. Case, Seth C. Adams, W. J. Floyd, A. E. Baker, F. E. Osborne, Professor Magnus C. Ihlsing, Charles G. Whyte, Louis Dornbusch, Edwin Hopkins Seaman, Wallace Cudcliff, Joel B. Ives, F. Schwanbausser, Norman A. Paul, Harry French, Edward Hartmann, Frank Cleary, John Benj. Brown, John Ryan, Edward B. Stott, William Weidman, L. R. Wetherwax, Ernest W. Muller, Carl Stueve, Anson S. Rice, Walter M. McBride, John Bittner, E. W. Stevenson, William J. Ladley, Edgar B. Benjamin, Francisco Laurent Godinez, W. F. Hurlburt and J. F. Bidstrup.

## *An Electrical Dinner.*

Mr. A. M. Young, who controls a large number of electric lighting and electric railway companies, gave a dinner on Saturday evening, February 7, to the managers of these companies and several friends. The dinner was served at the Union League Club, on Fifth avenue, New York city, and was a very delightful affair, a number of the gentlemen present speaking ably and interestingly respecting the interests they represented. The occasion will be long remembered, and Mr. Young announced that it would be repeated annually hereafter.

Those present besides the host, were:

| | | |
|---|---|---|
| B. W. Stillwell. | J. S. Cowling, | Walton Clark, |
| Geo. J. Roberts, | C. H. Werner, | J. C. DeLong, |
| A. Anderson, | E. B. Seymour, | G. G. Blakeslee, |
| A. P. Deeds, | W. S. C. Wiley, | C. Loomis Allen, |
| H. E. Andrews, | Thos. E. Murray, | Nicholas Brady, |
| E. A. Leslie, | W. W. Freeman, | A. N. Neilsen, |
| F. A. Stratton, | Howard Davis, | J. B. Thomson, |
| E. H. Williams, | Wm. Darbee, | Ray Smith, |
| A. J. Purinton, | Fred T. Ley, | A. W. Paige, |
| W. G. Bushnell, | A. O. Shepardson, | Geo. O. Baker, |
| Ronald Crawford, | J. H. Golding, | C. M. Heminway, |
| P. H. Hampson, | F. M. Tait, | A. J. Campbell, |
| M. J. Warner, | E. W. Poole, | A. E. Hammer, |
| W. A. McClurg, | F. L. Terry, | A. V. Wainwright, |
| R. A. C. Smith, | Wm. M. Lewis, | H. G. Runkle, |
| G. E. Williams, | H. L. Merry, | Paul T. Spencer, |
| E. L. Brundrett, | R. Norris, | Geo. F. Coffin, |
| | W. T. Hincks. | |

# Power Required to Drive Machine Tools.

*Test Made in the Locomotive Shops of the Buffalo, Rochester & Pittsburg Railway at Du Bois, Pa.*

THE following tests were made with the purpose of ascertaining the amount of power used by various machine tools when operating in regular, routine work, and at the same time the power lost in shafting and belting in a group-driven system, which, to be more explicit, might be stated as follows: If all the machines in a group were thrown on and driven at their highest capacity at one time, they would in most cases probably require an amount of power approximating the capacity of the motors as they are installed in this plant. However, in the conditions of actual, daily operation, this never happens. Some of the tools are always either standing idle or working lightly, and the amount of power demanded hardly ever reaches half of the possible maximum total. The load-factor is the ratio of the average power to the maximum.

The plant of the Buffalo, Rochester & Pittsburg Railway Company, at Du Bois, Pa., consists of five buildings: the power-house, a building containing the locomotive-erecting, boiler and machine shops, the round house, the blacksmith house, and the storehouses and offices. These buildings are located on a plot of ground thirty-two acres in extent and the equipment is intended to handle the repairs of about 150 locomotives, with provision for an increase of seventy-five engines, which is expected to cover about five years, making an estimated ultimate total of seventeen engines per month. The machine, boiler and tank shops are under one roof, covering an area of 134 by 524 feet. The blacksmith shop is 80 by 140 feet, the power-house 63 by 93 feet, the office and storehouse 60 by 120 feet; and in addition to these, there is an oil house 30 by 60 feet, a 16-stall round house, and a 26 by 140 feet coal, coke and iron storage building.

The storehouse contains general storeroom facilities on the first floor, and offices, draughting room, etc., on the second floor.

The power plant, which, as above stated, is located in a separate building, is designed for the transmission of power by electricity and compressed air, and furnishes all power needed for driving the machinery, lighting the shops, grounds, a large car building plant, and neighboring stations, and the further supply of steam for heating the buildings. All pipes and wires pass from the power-house to the several buildings through underground galleries. The boiler equipment comprises four 200-horse-power water-tube boilers, the furnaces of which are hand fired. The engine room contains the following machinery:

A 200-horse-power compound engine, direct-connected to a 125-kilowatt, direct-current, compound-wound generator,

WHEEL SECTION OF THE MACHINE SHOPS OF THE BUFFALO, ROCHESTER & PITTSBURG RAILWAY AT DU BOIS, PA.

operating at 250 volts and 280 revolutions per minute. This generator carries the day load and supplies power for machine tools, cranes, lighting, etc.

A 100-horse-power simple engine, belt-connected to a seventy-five-kilowatt, direct-current, compound-wound generator, operating at 250 volts and 750 revolutions per minute. This generator carries the night load and supplies power for lighting, motor driving for special night work and the turntable. The night and load generators are interchangeable at the switchboard.

A 100-horse-power, simple engine, belt-connected to a sixty-kilowatt, two-phase, alternating-current generator, operating at 200 volts, 7,200 alternations and 900 revolutions per minute. This generator furnishes power for lighting the yards, the Falls Creek station, the passenger and freight stations at Du Bois and the Du Bois car-shops.

A two and one-half horse-power exciter, operating at 125 volts and 180 revolutions per minute.

This apparatus is all of Westinghouse make. In addition to these are a standard marble switchboard, and an Ingersoll-Sergeant, steam-driven compressor, furnishing compressed air for the plant.

The results of the tests are given below, at length, with all particulars, the net power consumed by each tool or group of tools being stated. It is to be noted in reading these results that the net power consumed by the several tools and by the line shafting was not obtained directly, but by subtraction. All measurements were made by means of a voltmeter and an ammeter in the motor circuit. These indicated the electrical horse-power delivered to the motor. The brake-horse-power delivered by the motor at any given load was then determined by means of the motor efficiency curve. This is a source of considerable error at low readings, since the actual efficiency of the motor as installed may differ from that given on the curve sheet. The amount of power consumed by the shafts and belts being known and then the amount consumed with the tool running being taken, the first quantity was subtracted from the latter to give the amount actually consumed by the tool. This probably gave very nearly the correct results, since the energy lost in shafting and belting is very nearly constant at various loads. The tests were made while the shops were in full daily operation, and it was for that reason impossible, in many cases, to make as direct measurements as might seem desirable. In order, therefore, to present the actual conditions of the test the log has been given below in full as recorded, except that all readings are translated into brake-horse-power delivered at the tool. In explanation of the small loads allotted to some of the motors, it should be stated that when they were selected provision was made for the probable increase in the capacity of the shop. Experiments are, also, being conducted with high-speed cutting steels, which, if adopted, will considerably increase the demands for power.

These tests, in addition to furnishing accurate data relating to the power required for various tools when starting, running light and cutting, also make possible some estimation of the merits of roller bearings for shaft-hangers. The line shafts are cold-rolled steel and are carried on Hyatt roller bearings, and a shaft 200 feet long without belts could be turned by hand. But in spite of the unusual efficiency of the bearings, it will be noted that the power consumed by the tool is often less than that lost in transmission. Nevertheless, the capacity in the motors required for the group drive is two and one-half times smaller than it would have been had each tool been provided with an individual motor. It is a question as to how far the low average power taken by large groups of tools in operation may be due to the flywheel action of the shafts and pulleys.

The locomotive-erecting, boiler and machine shop consists of a middle aisle for erecting and two shed bays equipped with shafting for driving the machine tools. Two fifty-ton, electric traveling cranes have a runway in the middle aisle. There are five lines of shafting driven by five shunt motors in the shed bays, and the sections are designated as wheel section and boiler section in one bay, and lathe, tool and flue sections in the opposite bays.

WHEEL SECTION.

Shafting is driven by a forty-horse-power, shunt-wound motor and operating the following machinery: forty-two-inch car wheel boring mill, forty-eight-inch car wheel lathe, two seventy-nine-inch wheel lathes, quartering machine, sixty-inch by sixty-inch by eighteen-inch planer, eighty-four-inch boring drill, single axle lathe, six-foot radial drill, eighteen-inch slotter, band saw, No. 7 grinder, water tool grinder.

The line shaft is 200 feet long, two and one-half inches in diameter, and has twenty-six hangers. It was inconvenient in this instance to obtain a test of the line shaft alone. A test of the line shaft and counters only gave 1.5 horse-power.

A fifteen-minute test was made of a group of machines, comprising one seventy-two-inch and one sixty-six-inch wheel lathes, each with two cuts, a wheel press operated at fifty tons, and an eighty-four-inch Niles boring mill, a band saw belt, an emery wheel, a Pond radial drill, and a sixty-inch planer with one tool cutting cast iron, with an average result of 4.6 horse-power, a minimum of 0.88 horse-power and a maximum of 10.43 horse-power. The speed of the line shaft was 160 revolutions per minute.

Two machines were thrown in, a forty-two-inch wheel lathe cutting with one tool and an eighty-four-inch boring mill—with the wheel lathe cutting, the boring mill on starting up took 6.9 horse-power, and cutting three horse-power.

To the above two machines were added a tool grinder and a seventy-nine-inch wheel lathe cutting, which starting up took 6.3 horse-power and running steadily 3.95 horse-power.

To the above was added a sixty-inch planer, cutting a cast-iron cylinder, which at starting up took 10.3 horse-power, and running steadily 4.2 to 7 horse-power, or an average of 6.1 horse-power during the whole time.

To the above were added another tool grinder and an eighteen-inch slotter. The maximum reversals of the planer and the slotter at the same instant, gave 15.5 horse-power, and steady running showed 5.2 horse-power. The planer interfered somewhat with the readings.

To the above was added a band saw cutting four-inch oak, which took 5.6 horse-power. Whether the saw was cutting or not seemed to make no difference in the reading.

Tests of single machines were then made; that is, of the power consumed by the one machine tool thrown in at a time. A forty-two-inch wheel lathe with one tool cutting took on starting up 4.6 horse-power, and on steady running 0.5 horse-power; an emery-wheel took 0.7 horse-power; a seventy-nine-inch wheel lathe, with two tools making roughing cuts on a pair of drivers, took 4 horse-power; an eighty-four-inch boring mill boring an eight-inch cylinder, took two horse-power; a sixty-inch planer cutting a cast-iron cylinder, took two horse-power, and a maximum at reversal of 8.5 horse-power; an eighteen-inch slotter, with tools of three-quarter-inch face cutting steel, took 0.3 horse-power, and a maximum at reversal of 1.2 horse-power; a band saw starting up took 6.3 horse-power, and running light or cutting four-inch oak, four horse-power.

A group run of an eighty-four-inch boring mill, a seventy-nine wheel lathe, a

six-foot radial drill, a sixty-inch planer, and an eighteen-inch slotter gave at steady running 6.9 horse-power, and with the planer at reversal took 14 horse-power.

BOILER SECTION.

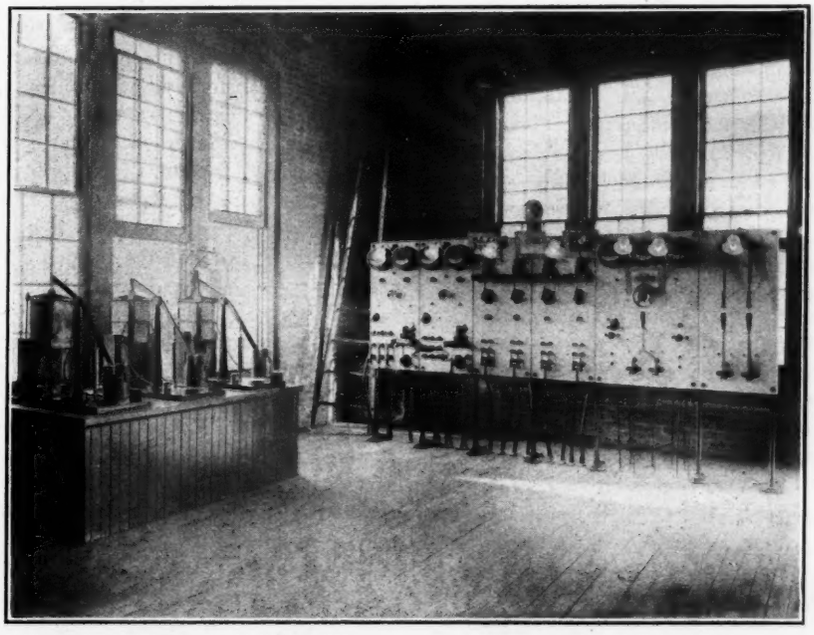
Shafting is driven by a thirty-horse-power, shunt-wound motor and operating: twelve-foot bending rolls, bolt cutter, stay-bolt cutter, drill press, tool grinder, Brooks plate planer, horizontal punch, shear and punch, six-foot bending rolls, six-foot straightening rolls, six-foot radial drill.

All the counter-belts were thrown off and the line shaft tested alone, with a result of 0.3 horse-power. This line shaft is 170 feet long, two and one-half inches in diameter and has nineteen hangers. The speed of the line shaft was 158 revolutions per minute.

A test of the line shaft and countershafts, only, gave an average of two horse-power.

The machines comprising the first group tested were: A stay-bolt cutter and a bolt cutter, a No. 4 Hilles & Jones punch and shear. The No. 4 punch and shear was punching thirteen-thirty-seconds-inch holes in three-sixteenths steel plate. A fifteen-minute test showed an average of one horse-power, with a minimum of 0.2 horse-power and a maximum of 3.5 horse-power.

A single tool, the No. 4 Hilles & Jones



SWITCHBOARD INSTALLED IN POWER-HOUSE OF THE BUFFALO, ROCHESTER & PITTSBURG RAILWAY AT DU BOIS, PA.

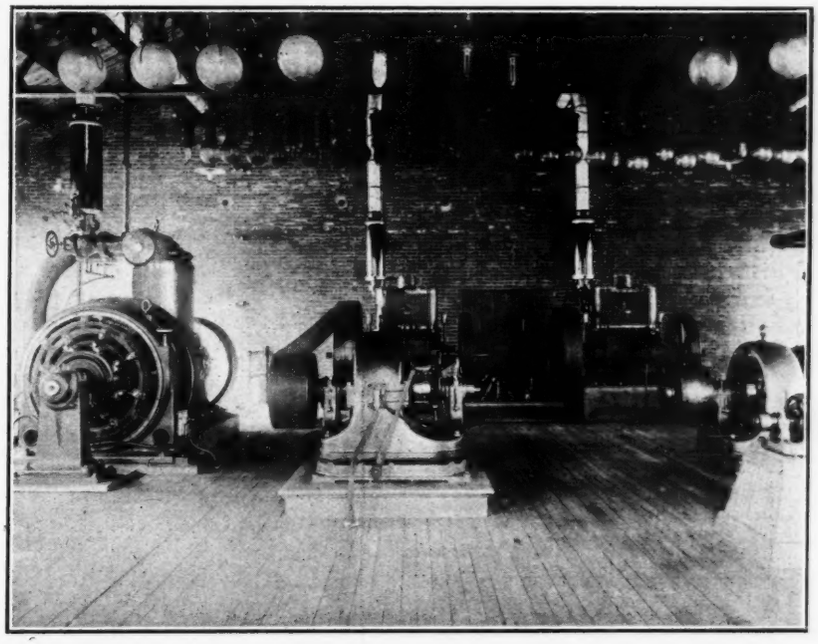
forty-eight-inch punch and shear, was then thrown in, and starting up light took 6.9 horse-power, settling down to 0.4 horse-power. Shearing five-sixteenths-inch steel plate, it required three horse-power. A six-foot radial drill was then added, and at starting up light took 3.6 horse-power, settling down to 1.1 horse-power. A one and one-half-inch drill cutting in steel gave 1.5 horse-power.

A six-foot radial drill and bolt cutter required 1.1 horse-power.

The twelve-foot rolls were then added, and starting up light showed 7.3 horse-power, settling down to 4.75 horse-power. Rolling steel plates, one-half-inch by eight-inch, required 5.3 horse-power.

A test of line shaft and counters, with the six-foot radial drill cutting steel with one and one-half-inch drill, and a punch and shear running light, showed two horse-power.

A one-inch stay-bolt cutter added to the above took on starting up 4.5 horse-power, and cutting twelve threads per inch gave 2.1 horse-power.



INTERIOR OF POWER-HOUSE, BUFFALO, ROCHESTER & PITTSBURG RAILWAY, DU BOIS, PA.

LATHE SECTION.

Shafting is driven by a thirty-horse-power, shunt-wound motor and operating: 24-inch crank planer, 36-inch by 36-inch by 20-foot planer, 51-inch boring mill, 16-inch shaping machine, 24-inch lathe, 24-inch drill press, 37-inch boring mill, two 22-inch lathes, three 16-inch lathes, two 18-inch lathes, 28-inch lathe, 43-inch lathe, 2-inch by 24-inch flat turret lathe, two 26-inch by 26-inch by 10-foot planers, 60-inch horizontal boring machine, water tool grinder, centering machine.

The line shaft and counters gave 4.1 horse-power.

A test of the line shaft with counter-belts off gave 0.7 horse-power. The speed of the line shaft was 155 revolutions per minute. The line shaft is 180 feet long, two and one-half inches in diameter, and has twenty-two hangers.

A fifteen-minute test was made of a group of machines comprising two twenty-six-inch planers and one thirty-six-inch planer, cutting steel with one tool each, a turret lathe, an emery wheel, three sixteen-inch lathes, two twenty-two-inch lathes, a thirty-six-inch boring mill,

drill press, and a shaper, all in operation. The readings gave an average result of 6.9 horse-power, a minimum of 4.74 horse-power and a maximum of fifteen horse-power.

A group run of a twenty-six-inch planer, three sixteen-inch lathes, an eighteen-inch lathe, a twenty-four-inch lathe, a sixteen-inch shaper, a twenty-four-inch drill press, and a centering machine in operation required at steady running 2.4 horse-power, and at reversal of the planer 7.6 horse-power.

A single twenty-six-inch planer cutting cast iron took one horse-power, and at reversal 3.5 horse-power.

A sixteen-inch shaper cutting one-thirty-second-inch steel at twelve-inch stroke took 0.9 horse-power, with a minimum of 0.2 horse-power and a maximum of 1.4 horse-power.

A twenty-four-inch turret lathe cutting required 0.3 horse-power.

A twenty-four-inch lathe boring brass took 0.03 horse-power.

TOOL SECTION.

Shafting is driven by a twenty-horse-power, shunt-wound motor and operating: tool grinder, drill grinder, 21-inch drill press, 16-inch lathe, milling machine, grinding machine, three 18-inch turret lathes, 24-inch drill press, 28-inch lathe, No. 10 vertical milling machine, two-spindle rod drills, 14-inch pillar shaper, 16-inch lathe, 26-inch by 26-inch by 6-foot planer, 32-inch drill press, surface grinding machine, water tool grinder.

The line shaft and counters required 2.8 horse-power. The line shaft is 140 feet long, two and one-half inches in diameter, and has twenty hangers. It was not convenient to obtain a test of the line shaft alone. The speed of the line shaft was 155 revolutions per minute.

The line shafts of the lathe and tool sections can be connected by a clutch coupling and the whole operated from either motor.

A group test was made of a sixteen-inch lathe, a drill press, and a grinder, all in operation, with a result of 1.9 horse-power.

A single grinder took in starting up 9.7 horse-power, and grinder 1.95 horse-power.

A twenty-eight-inch lathe took on starting 4.7 horse-power, and cutting steel 2.5 horse-power.

A group run of two sixteen-inch lathes, shaper and two grinders in operation showed 2.5 horse-power.

FLUE SECTION.

Shafting is driven by ten-horse-power, shunt-wound motor and operating: flue welder, flue cleaner, two No. 7 Jarecki pipe threading machines, two pipe cutters.

A test of the line shaft with all counters gave 0.6 horse-power.

A test of the line shaft gave 0.035 horse-power. The line shaft is ninety feet long, two and one-half inches in diameter, and has twelve hangers.

A single flue welder with blowing fan attached required on starting up 7.1 horse-power. Running light it took 3.4 horse-power.

The pipe cutter, cutting two and one-half-inch pipe, took 0.06 horse-power.

The auto-flue cleaner, cleaning two-inch flue, took 0.2 horse-power.

Outside at the end of the machine shop is a flue rattler operated by a seven and one-half-horse-power, shunt-wound motor.

BLACKSMITH SHOP.

The blacksmith shop is driven by a forty-horse-power, shunt-wound motor, which is belted to seventy-five feet of two and one-half-inch line-shafting with twelve hangers. The apparatus driven comprises a bolt header, a twenty-five-inch punch and shear, a cutting-off saw, a tool grinder, a forty-inch planer, a drill press, a fifty-pound hammer, a blower, and an exhaust fan.

A test of the line shaft and counters with grindstone and two blowers constantly in operation gave 14.5 horse-power.

The bolt header added to the above gave on starting 7.8 horse-power, running light 0.5 horse-power, and heading one-inch bolts 3.5 horse-power.

A No. 2 Hilles & Jones punch and shear added to the above, first condition, gave on starting up 5.5 horse-power, running light 0.5 horse-power, and shearing one and one-half-inch round bar 4.3 horse-power.

TURNTABLE.

The turntable is seventy feet long, and is operated by a ten-horse-power direct-current motor of the street railway type, geared to an independent traction wheel; the driving combination being supported in a pivoted frame, or "donkey," which rests with all its weight upon the turntable track, even when the table is tipped by a locomotive. The power is led to the motor through a sliding contact placed on the bridge above the centre of the turntable.

With the table running light and the controller on full, a test gave 4.45 horse-power.

In throwing on the controller and accelerating up to full speed, five horse-power was attained, which dropped to a constant of 4.45 horse-power.

With a locomotive on the table, weighing, with tender, approximately 286,000 pounds, a test gave 7.35 horse-power, when accelerating at full speed. When full speed was attained, the test showed 5.43 horse-power.

POWER-HOUSE.

Switchboard readings of the ammeter and voltmeter were taken every five minutes from 1 P.M. to 5.30 P.M., with averages of 220 volts and 250.7 amperes, or 73.8 horse-power. The minimum current was 200 amperes, or fifty-nine horse-power, and maximum current 300 amperes, or 88.5 horse-power, the average of which is 250 amperes, or 73.75 horse-power.

These tests were carried out by Messrs. H. M. Palmer and George H. Gibson, of the Westinghouse Electric and Manufacturing Company, and were made possible by the courtesy and permission of Mr. F. T. Hyndman, master mechanic, and the kind assistance of Mr. C. D. McArthur, chief draughtsman of the Buffalo, Rochester & Pittsburg Railway Company.

## *Transformer Construction.*

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In your December 27 issue you comment editorially on transformer recently built by the Oerlikon Company for 50,000-volt transmission. There is evidently a serious mistake in the figures you give for material used in these transformers. The same mistake occurs in the description of the transformers as given by the London *Electrician* for December 5. The weights, in accordance with your statement, are but 100 pounds for copper and 550 pounds for iron, whereas the actual amounts could hardly be less than ten times these figures. In the London *Electrician* article the core loss is given and corresponds to a loss of twelve watts per pound, an amount which would be absolutely prohibitive on the basis of heating. Very likely some one else has already called your attention to this error, but thinking possibly this is not the case and that you would not want an error to go uncorrected, I take the liberty of pointing out the mistake. WALTER S. MOODY.

January 24.

[In our comment on this transformer the London *Electrician* was given as our authority. The figures were quoted correctly from the columns of that careful journal. Since our correspondent questions them, the matter will be investigated and the figures verified or corrected, as may be necessary.—ED.]

# INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—V.

## *Notes on Progress in Europe and America.*

BY JOHN B. C. KERSHAW.

### *Electrogalvanizing.*

The use of electrolysis for obtaining a deposit of zinc on iron has been practised now for many years, but although several electrogalvanizing works have been erected in Europe and America, the industry does not develop rapidly, and the greater number of galvanized iron articles found in commerce is produced by the old method —dipping in molten zinc. This slow growth of the electrogalvanizing industry is partly due to the great care and attention necessary in order to obtain uniform, bright and adherent deposits of zinc on articles of irregular shape by electrodeposition. Not only must the article be thoroughly cleaned and freed from every particle of grease or dirt, but the strength, temperature and purity of the zinc solution used in the bath must be carefully regulated, and anodes of special design are also necessary with many of the articles submitted to the process. Finally, the current density and electromotive force require careful attention in order to obtain the best possible results.

That the electrogalvanizing process should find industrial use in spite of these necessary precautions is proof that there must be some important advantages attaching to its employment, and the fact that the famous German firm of Krupp has established an electrogalvanizing works at Gaarden would indicate that these advantages are real and not imaginary in character.

A recent proposal for increasing the efficiency of the process is contained in a French patent—No. 318,163—granted to Paweck. This inventor proposes to use boric acid and borates in the bath, in conjunction with ammonium sulphate or other salts of the alkali metals. The objects to be coated with zinc, when small, are enclosed in a perforated drum, mounted on a horizontal axis, and this is rotated in the electrolyte while in connection with the negative leads. When large objects are to be coated, these are suspended in a stationary position in the bath, and the anodes are rotated, preferably when mounted as spokes on vertical axes. This rotation is designed, in each case, to produce circulation and mixing of the electrolyte.

The only novel portion of this patent would appear to be the use of boric acid or borates in the bath. The use of revolving perforated drums and the need for good circulation in the electrolyte are well known, and have been published countless times in patents, text-books and technical journals.

### *The Ampere Electrochemical Company.*

The works of this company at Niagara Falls are in some respects the most interesting of all the undertakings grouped at this centre of electrical power, for they represent a distinct step forward in the industrial development of new processes. In the past, the inventor who has worked out the details of a new process in his laboratory, has usually been compelled to float a small company or syndicate in order to raise the capital required for the trial of his invention or process upon a large scale of operations. If he has the misfortune to fall into the arms of a professional company promoter, this intermediate stage is dispensed with, and a large capital is raised and a factory is built for the operation of a process which is too often found inefficient when transferred from the laboratory to the works—and the result is financial failure. Along one or other of these two paths the industrial development of most of the electrochemical and electrometallurgical processes now operating, has occurred. It is unfortunately too true that the second path has been followed in many instances both in Europe and America, and that much capital has been already lost and will still be lost in these abortive attempts to found new industries. The founders of the Ampere Electrochemical Company propose to remedy this state of affairs, and to simplify the second stage of development. Their factory at Niagara is really a research laboratory on a large scale, and the processes which have been worked out in the laboratories, by a trained staff of chemists and electricians, are submitted without delay to industrial trials in the factory, under the charge of the men who have worked out the details of the processes up to this stage. The advantages of the plan are obvious. The fact that the processes used by the Norton Emery Wheel Company, the United Barium Company, and the Atmospheric Products Company are based upon the experimental work carried out in 1901 and 1902 in the laboratories and factory of the Ampere Electrochemical Company, is proof that this company is engaged in work which is both useful and profitable.

### *Electrochemical Instruction in Germany.*

Germany was the first country in which the scientific study of electrochemical problems received attention, and it is therefore not surprising that the provisions for study of electrochemistry and electrometallurgy at German universities are more elaborate and complete than those of other countries.

It is true that in recent years the facilities for practical electrochemical and electrometallurgical study have been greatly increased in both England and America, and in each of these countries electrochemical laboratories may now be found attached to colleges of technical schools, the equipment of which will compare favorably with anything of the kind existing in Germany. But in the provision of lectures upon these new branches of science, Germany is strikingly ahead of England and America; and the following list of German universities and polytechnics, where such courses have been planned for 1902 and 1903 (taken from the *Zeits. f. Electro-chemie* of September 11, 1902), shows how general is the interest taken by the educational authorities in electrochemical and electrometallurgical science:

Aachen, Basel, Berlin, Berne, Bonn, Braunschweig, Breslau, Darmstadt, Dresden, Erlangen, Freiburg, Gottingen, Halle, Hanover, Heidelberg, Karlsruhe, Kiel, Leipzig, Munster, Rostock, Strassburg, Wurzburg and Zurich.

Perhaps the most remarkable feature of the provision in Germany for study of these new branches of science, is the number of separate lecture courses arranged; and the number of professors and assistants engaged for the same in one university or polytechnic. Thus at Berlin there are ten separate courses of instruction, and eleven professors and assistants engaged in teaching these branches of science at the university and polytechnic. At Darmstadt the respective totals are seven and five.

Neither England nor America could yet provide such a profusion of professors and assistants competent to deliver courses of lectures on these new branches of knowledge. But as already remarked, each of these countries is now giving attention to the matter, and in time it is probable that the study of the science will receive as much attention as is now being devoted to the practical and industrial side of the subject.

The German is by nature scientific, and the Englishman and American, practical. This difference in character partly explains the tendency in Germany to study principles, and in England and America to apply them to industrial uses. Practice, based on half-knowledge of principles, however, sometimes ends in disaster.

# Electrical Notes from Europe.

*By Our Special Correspondent.*

THE new Paris-Rome telephone line, which will be shortly opened for use, is the longest of the European telephone lines in operation, having a total length of 956 miles. It has 456 miles on the French side, running from Paris by way of Lyons to Mount Cenis, and 500 miles on the Italian side. From Mount Cenis the line passes southward by Turin, Bologna, Florence and Siena to Rome. The total of 956 miles exceeds the Paris-Berlin telephone line, and also the Berlin-Budapest. On the Italian side the line has 266 miles running along the railroad and 234 along the highway. New poles have been erected over 264 miles distance, and for the remainder the poles of the existing lines have been utilized, and the wires are crossed at every kilometre to avoid the effects of induction. The Paris-Rome line passes in the central station of Turin and also in that of Voghera, which is a terminal point for two main lines; one of which runs to Milan, thirty-nine miles, and the second to Genoa, or ninety-four miles. In this way Milan and Genoa are connected with Paris, and also with Turin and Rome. Besides this, Milan has a direct connection with Turin by a special line of ninety-one miles in length. It is foreseen that the new international line will soon be overcrowded, and no doubt a single line running to France will prove insufficient for the needs of the service, since it will be necessary to connect between Turin, Milan and Genoa on the one hand, and Lyons and Paris on the other. A project has already been proposed for running a second circuit.

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The high-tension electric line from Lecco to Sondrio, with a branch to Chiavenna, which is operated by the Central Italian Railroad Company, is now running a number of trains daily which takes three-phase current of 3,000 volts and fifteen cycles from a double overhead wire, using the rails as a return. The total length of the lines is 44.5 miles. The rolling stock includes both passenger and baggage cars. The passenger trains are made up of a motor car with a certain number of trailers, while an electric locomotive is used for the freight trains. At last accounts there were ten motor cars and five locomotives running. The former have double trucks of two axles each, carrying on each axle a three-phase motor which is mounted concentric to the axle by means of a hollow shaft which turns on ball-bearings. Two types of passenger cars are used, the trucks being the same for both. Five of the cars are equipped as first-class and contain forty passengers, with baggage. The total weight of these cars is fifty-three tons. The other five cars, weighing fifty tons, are divided into second and third-class compartments, containing twenty-four and thirty-two persons, respectively, or fifty-six persons in all. Each of the motor cars can draw a load of forty tons at a speed of thirty-five miles an hour. The cars thus have four three-phase motors, and in practice two of the motors have the stator or fixed part working at a high potential, taking 3,000 volts from the trolley circuit. When running at full speed the two motors work alone. The revolving armature has its winding in circuit with resistances which are inserted at the time of starting and then thrown out when running at full speed. The resistances used for this purpose consist of a set of metal plates immersed in a carbonate of soda solution, and the resistance is varied by causing the level of the liquid to rise and fall under the action of compressed air. To work at half four-speed, in place of short-circuiting the armatures of these last motors or putting them on resistance, each is connected to the armatures of the second motor on the same truck, and the field circuits of the latter are thrown on the liquid resistance or in short-circuit. The locomotives which draw the freight trains have also a double truck with two motors on each. The four motors give a tractive effort of 4,500 kilogrammes at the normal speed of twenty miles an hour, and take a load of forty-five tons in freight cars. The four motors of the locomotives are alike, and for starting, the armatures are put on a liquid resistance as above; when the normal speed is reached these resistances are cut out by short-circuiting. The locomotive uses from one to four motors at a time, according to the power required, and this keeps the efficiency high. The electric outfit has been furnished by Ganz & Company, of Budapest. The two overhead wires of 0.32 inch diameter are placed two and one-half feet apart, and a special form of double trolley is used, formed of two copper rollers insulated from each other and running on ball-bearings. The two rollers are held at the proper distance apart by a cross-brace. At the crossings and switches a somewhat complicated arrangement is used in order to avoid short-circuit. One of the line wires is replaced by a short section of dead wire which serves simply to keep the trolley in place, and the speed of the car is sufficient to carry it past this point. It will be remembered that this line is supplied from a large 20,000-volt plant which has been erected on the banks of the Adda, at Morbegno, close to the railroad line. At this point a 100-foot fall has been secured. At present the station contains three alternators of 1,400 kilowatts, driven by horizontal turbines of 1,500 horse-power, working at 150 revolutions per minute. The feeder circuit, at 20,000 volts, supplies a series of nine substations along the railroad line. The substations, which are small stone buildings, contain only the transformers and a small switchboard and do not need an attendant. The Lecco substation contains two three-phase transformers of 300 kilowatts each, while the rest have each one transformer of the same capacity. At present the trains run at a regular and somewhat moderate speed, from thirty-five to forty miles an hour.

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The type of electric automobile which is shown in the illustration has proved quite a favorite in Paris, and a number of these vehicles were to be seen at the last automobile show. While the general make-up of the automobile is of the type preferred here, the chassis and electrical outfit have been built by the Electric Vehicle Company, which exports quite a number of these trucks to France annually, thus furnishing another instance of the rapidity with which American electrical products are gaining ground on this side of the water. The automobiles are built in Paris by the Electromotion Company, which has designed various types of carriage-body to be mounted on the Columbia trucks. The illustration represents a type of coupé in which the back part can be folded down so as to form an open vehicle when desired.

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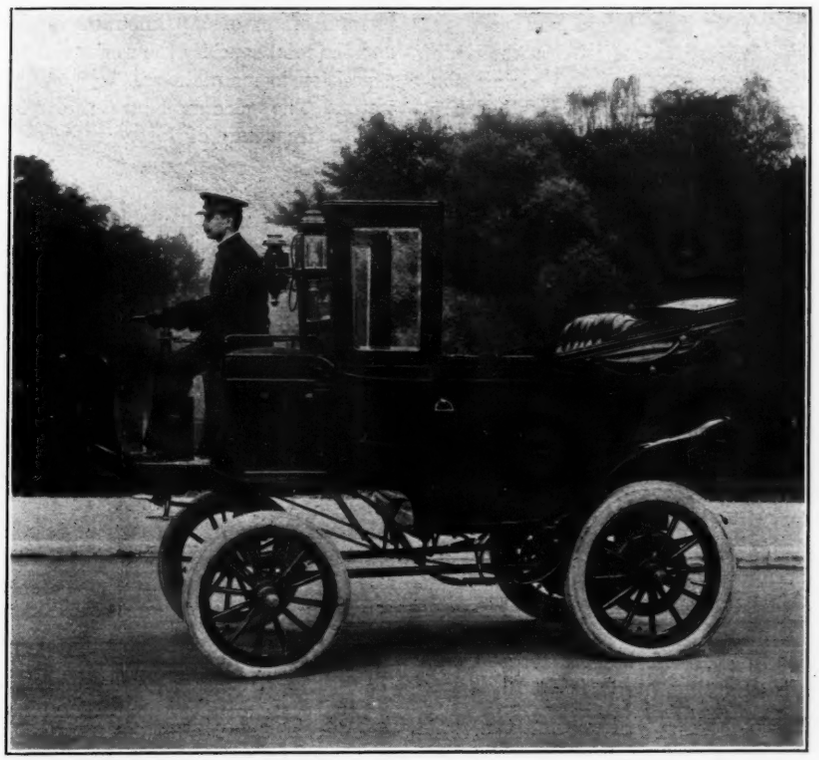
A number of projects have been presented for the rapid transit electric railroad between Antwerp and Brussels. One of the most important is the Hertoghs project, which has been presented by the

Interprovincial Syndicate at Antwerp. The line after leaving Antwerp will cross the Ropel between Heyde and Hollegat, and will terminate at Brussels at the Place de Brouckere, where it is proposed to erect a large depot. The trains will be spaced every ten minutes, and are made up of a motor car and one or more trailers, which will be divided into first and second-class compartments. During the hours of crowded traffic the trains will be run more frequently. The average speed provided is from sixty-five to seventy miles an hour, but it is expected to increase the speed to eighty miles an hour. According to the Empain project the line will be made as short as possible between the two cities and will thus be 26.4 miles long. The curves will not be below 6,000 feet radius. It is proposed to use a long car with central passage, mounted on double truck, and the trains, to be made up of two cars, will leave either city every ten minutes. The state is to receive fifty per cent of the net receipts. If the minimum speed allowed, which is sixty miles an hour, is not attained after one year's operation the company will forfeit part of the receipts—this to be in proportion to the speed attained.



New Type of French Electric Vehicle.

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An extensive system of canal traction is that which is to be carried out on the Teltow Canal which is now in construction and will connect the Havel with the Spree, near Berlin. The administration has decided to use the system of electric traction exclusively, and to this end instituted a concourse which brought out a number of projects from different engineering firms. Among the projects which received favorable attention were those of Siemens & Halske and Feldmann & Zehme. In the former system it is proposed to use electric traction by trolley locomotives, which will run along either bank. The track will have two rails, one of which is heavier than the other and weighs sixteen kilogrammes per metre, while the other is of light section. To pass the lakes of Gribnitz and Machnow electric towboats, provided with accumulators, will be used. The current necessary for the system will be supplied by two main generating stations of 360 horse-power capacity each, one of which is to be located at Teltow and the second at Britz. To charge the batteries of the towboats a third station will be erected on the banks of Lake Gribnitz, which will be operated by two gas engines. The locomotives used to draw the canal boats will be run by simple adhesion. They will have two series motors and their total weight is six and one-half tons. The two wheels which run on the main rail will carry eighty-five per cent of the total weight. The other wheels which run upon the smaller rail will receive the oblique effect of the traction. The current is brought by a trolley of the usual kind with a rail return, using 700 volts direct current. At the parts where the shifting of the canal boats from the locomotives to the towboats takes place, the hauling cables will be rolled and unrolled by a drum which is worked either by a handle or by a small electric motor. The locomotives have been designed so as to occupy as small a space as possible, and all the projecting parts such as levers, handwheels, as well as the motorman's cab, have been distributed so as to give a symmetrical form. As to the operation of the system, the canal is divided into three working sections, each of which will have a separate set of tractors, and these will circulate back and forth over the section, exchanging the boats at the proper points. Each boat will thus have three different tractors during the trip. To provide for the different obstacles along the route several methods will be adopted. In case of boats lying along the bank of the canal it will be only necessary to raise the attachment points of the hauling cable by a few feet. For obstacles of a permanent nature the level of the path is to be raised by a wood construction or an earth embankment. The locomotives will traverse the large ports of Lichterfelde and Britz upon iron bridges of 260-foot span. The project submitted by Feldmann & Zehme uses also electric locomotives, but the current is here taken from an insulated conducting rail raised somewhat above the rails of the track. At the start it is proposed to run along one bank alone, but should the traffic become greater both banks will be used. The haulage will be carried out in independent sections, using separate locomotives on each, and at points where two locomotives meet each other they will exchange cables and proceed back upon their path. A system of accumulator towboats will be used as before to pass the two lakes; these will have double helices, and the batteries will be charged at a special station erected for the purpose. The locomotives will have two motor-operated axles. Two main generating stations will supply current for the line. The weight of the locomotive is reduced as much as possible, but the adherence to the track will be increased by a special device. To this end a cylinder rolls against the third rail and is made to press against it by a lever which is connected to the main hauling cable. In this way a considerable pressure is obtained which acts to increase the adherence of the main wheels to the track.

C. L. Durand.

Paris, France, January 31.

# *Notes from Great Britain.*

*By Our Special Correspondent.*

SO FAR as the parliamentary notices for next session have been published, Mr. Morgan would appear to have withdrawn from his exploits in London underground railways. Mr. Yerkes is again to the fore with more lines, and all the rejected schemes of the last session are being revived. An effort is being made to appoint a royal commission or a select committee, which can only have the effect of prolonging a solution to the London traffic problem.

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The patent electric postal system devised by the Italian Signor Piscicelli is apparently viewed with favor by the Postmaster-General, as an uncontradicted statement has gone forth that simultaneous experiments are to take place in England and Italy. The inventor is now on his way to Great Britain on a visit to the postal authorities there.

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A visit to Italy has been arranged by the Institution of Electrical Engineers for April. This is a continuation of the series of annual visits inaugurated some years back which started with a tour in Switzerland. The visit this year will last from April 2 to April 9, and will include visits to the much-talked-of 3,000-volt Valtellina railway, the tomb of Volta at Como, the Milan-Varese electric railway, and the power-houses at Vizzola and Tornavento. In addition, of course, there will be visits to numerous manufacturing works. *Apropos* of foreign visits, it was mentioned at a recent meeting of the Institution that a tour to America in 1904 was quite among the possibilities, as an invitation has been received from the McGill University, and also from the American Institute of Electrical Engineers. Nothing definite has, however, been arranged.

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An accident at a public bath by which two men were unfortunately killed, by electric shocks, has resuscitated all the old-time sensation with daily papers as to the terrible dangers of electricity. The facts of the case are that a fault occurred on the electric light system by which some metal work in the baths became charged, and the men, coming into contact with it, received fatal shocks. To the lay mind, the question of the condition of the body never enters, but to the initiated it will be seen that the unfortunate victims, being partly immersed in warm water and no doubt standing upon the gun-metal cap to the water pipe, were in the best conceivable condition for receiving a fatal shock. At the inquest upon the victims, a rather deplorable state of affairs was revealed, the lesson of which should be seriously taken to heart by those engaged in designing and wiring public buildings. In the first place the architect engaged a consulting engineer who specified a system of encasing the electric light wires in iron tubing but with wooden fuse boxes, and earthing. This, of course, necessitated a number of earths, whereas if, as the wiring contractors advised, iron fuse boxes had been installed, and the system thus made absolutely continuous, one effectual earth would have been sufficient. Further, the wiring contractors in no way carried out the letter of the specification as regards earthing, although they certainly did the spirit. In this way the fault having occurred, no fuse was blown, and the iron partitions of the baths became charged, with the result spoken of above. As usual, now that two human lives have been sacrificed, no expense will be spared in putting the building in first rate order, electrically. In itself this state of affairs probably exists in more cases than one, but the fact that two deaths have occurred has made the matter a public one.

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The increase of the operations of electric traction lighting in Great Britain, so frequently called attention to in these notes, has brought forth the following notice from the Postmaster-General. In view of the spread of electrical undertakings, and the possibility of their interfering with the Post Office telegraphs, postmasters of towns at which there is no member of the engineering staff, are requested to inform the superintending engineer of the district of any work done by electric tramway or electric lighting undertakings which may come under their notice.

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The adoption of the metric system in Great Britain is being seriously considered and agitated, and a discussion is to take place at the Institution of Electrical Engineers at which some definite idea of the true opinions of leading engineers may possibly be gathered.

The Central Electric Supply Company's works, which have been built—or rather are being built—in order to supply electric power "in bulk" to two London electric supply companies, are now actually working. It is another instance of the quietude with which such engineering works are nowadays put into operation, neither banquet nor inaugural ceremony having taken place. The works generating pressure is 6,000 volts by means of Oerlikon dynamos and Willans engines, some sets being of 1,560 kilowatts capacity and others of 780 kilowatts capacity, and the total capacity the works will be in a position to maintain will be 8,580 kilowatts. The generators are three-phase, with a frequency of forty-six cycles per second.

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There are now 7,500 lines working at the Glasgow municipal telephone system, and over 8,000 additional wires have been already laid. Some 1,300 subscribers are awaiting connection, and in view of the fact that the borrowing powers of the corporation have now been exhausted, and that the system is working so successfully, a sum of £80,000 is to be borrowed. Some heartburnings still continue to take place at Tunbridge Wells, where, at the last moment, a sum of some $2,400 was discovered now to have been mentioned with negotiations for the transfer of the undertaking to the National Telephone Company. In spite of an endeavor to foist this upon the company, the corporation has to resign itself to meeting this liability. A license has been granted to the Oldham corporation, in cooperation with its suburbs, for a competitive telephone system.

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Mention was made some time ago of a desire on the part of the Swansea corporation to adopt the Dolter surface contact system of electric traction. In Swansea, at present, some lines are also leased to a company, which latter has now protested against the action of the local authority—presumably on the score of lack of intercommunication—in that when its lease was granted no mention of any but the trolley system was made.

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An electric lighting installation has been put into operation at Erith, which is the first of its kind in Great Britain, *viz.*, generation and distribution at 3,000 volts,

three-phase. The reason for this is a sparse network of supply, and, in conjunction with Nernst lamps for street lighting, the undertaking is a distinct departure from recognized designing practice in Great Britain. The alternators are of Belgian make, and are only small, the whole novelty of the installation being that mentioned above. From the point of view of size the affair is of no great importance.

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In the midst of all the rejoicings at the well-deserved success of Signor Marconi in wireless telegraphy, a little more publicity than usual has been given to some experiments by the War Office. The most important attempts at communication between the land and sea forces of the empire have been made between the naval base at Portsmouth and the military base at Aldershot, some seventy or more miles inland. This was accomplished recently, the receiving station at Aldershot being a captive balloon. A short time ago, too, experiments were carried out at the military exhibition at Manchester, communication being effected with several of the neighboring towns.

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At intervals we get, in Great Britain, instances of the gradually extending influence of the electric power companies. In some of the larger towns, such as Durham, Gateshead, Hertford, etc.—to pick a few at random—small stations have been into operation pending the development of the power scheme, while in many other instances all the details are being developed so as to be quite ready when supply is available from the large stations. One of the latest examples of a small municipality being supplied in bulk by a large power company is at Walker, which is in the area granted to the Newcastle-on-Tyne Electric Supply Company. As it happens, one of the company's substations is situated in the town, from which a supply is given by three feeders. The whole of the street lighting is by incandescent lamps. The equipment of the substation at Walker is on a par with that at Gosforth, recently illustrated in the ELECTRICAL REVIEW in a description of the Tyneside tramways.

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The power companies in other parts of the country are also making great efforts toward giving a supply at an early date. Among them may be mentioned the South Wales scheme, which will eventually have four stations. Two, in fact, are now building, and will contain large power, high-tension generating machinery, on similar lines to other large transmission schemes. In all the schemes in Great Britain, however, there is the one outstanding expense of having to put all the extra high-pressure, high-pressure and low-pressure mains underground.

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A very interesting and scientific discussion recently took place at the Institution of Electrical Engineers on the question of the photometry of electric lamps. The author was Dr. J. A. Fleming, who, among other things, showed some examples of an incandescent standard which he has devised. In order to ensure the filament remaining constant for the maximum period, he first burns it in an ordinary bulb for a certain length of time, and then transfers it to a bulb about three times as large as the ordinary eight-candle-power globe. With this he states that he has been able to obtain very good results indeed, and pointed out that such a method, if successful, has obvious advantages over the existing pentane standards of light. The discussion upon the paper was interesting, but, in the opinion of the author, all the speakers had missed the mark aimed at by the paper, *viz.*, the evolution of a standard standard of light. Many of the critics of the paper expressed a decided preference for the German standard, and one speaker maintained that, while so many experiment with different apparatus in different countries under different conditions, finality could never be reached. In connection with this, it may be remarked that our National Physical Laboratory is shortly to be equipped, through the generosity of Sir William Preece and others, with a very complete outfit of photometric apparatus, when it is hoped that work something akin to that accomplished by the German Reichsanstalt may be done.

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The final decision of the Postmaster-General concerning the transfer of the Tunbridge Wells municipal telephone exchange and system generally over to the National Telephone Company has robbed the actual transfer of most of its anticipated terrors. Coincident with the granting of a license to the corporation, the company, as regards its Tunbridge Wells area, was granted an increase of license until 1925, and thus, on the question of the transfer being raised, it appeared to have secured an advantage which could not be taken away from it, even by Parliament. But the new Postmaster-General tackled the problem with more tact than he had been given credit for. With him, and him alone, rested the sanction of the transfer, and he only did this on learning from the National Telephone Company that it would be willing to forego its increased license, and fall back upon the old one which expires in 1911. By this the company stands to lose, because its agreement with the corporation stipulated that the subscriptions should all be decreased. But the company has rid itself of a competitor, which is something. A. W.

London, England, January 31.

### *The Diesel Engine.*

At a recent meeting of the Scientific Society of Glasgow Technical College, a Mr. Wilkinson read a paper on the Diesel engine. Although originally Diesel aimed at a Carnot cycle of operation, this was not realized, and the Diesel engine differs but little from any other combustion engine. This engine, however, avoids compressing a combustible mixture, so that there is no temperature limit to compression, and this can consequently be carried to a red heat, and when the fuel is forced into this heated air it burns. A pump maintains the air pressure in three reservoirs. This is used for forcing fuel into the engine and for starting the engine. It is customary to send out a charged reservoir with each new engine, for starting. The Diesel Company is building engines up to 250 horse-power, and will quote up to 1,000 horse-power. The engine will use as fuel oils of the benzine type, petroleum lamp oils and fuel oils, or even crude Russian or other heavy oils. Alcohol can be used if cheap enough, as also can animal and vegetable oils. With oil at four cents per gallon, a consumption of 0.47 pound per brake horse-power-hour works out to 0.2 of a cent per horse-power-hour.

### *Report of the British Post Office Telegraphs.*

The report of the British Post Office Telegraphs for the year ending March, 1901, has been given out. This shows that the system comprised 45,702 miles of line. The total length of wire was 345,603; the number of instruments in use 37,952, and the staff composed of 172,184 persons. The number of telegrams forwarded for the year was, inland, 81,925,871; foreign, 10,712,466, the aggregate being 92,648,337. The average number of words transmitted weekly for the press was 16,065,602. The receipts were £3,385,588 ($16,927,940). The expenditures were £3,654,705 ($18,273,525). The expenditures have also exceeded the receipts for each of the four preceding years. This item includes the cost of construction for new lines.

## AUTOMATIC VOLTAGE REGULATORS.*

BY H. C. WIRT.

In order to give satisfactory electric service where constant-potential current is furnished, the current must be supplied at almost constant pressure. A variation in pressure of only one per cent has a marked effect in the life and candle-power of incandescent lamps. An increase in pressure of one per cent will reduce the normal life of an incandescent lamp about eighteen per cent and will increase the candle-power six per cent. A variation in pressure will also change the speed of motors. From the above it will be seen that it is of the greatest importance to the welfare of a central station that the current is delivered to its customers at a constant voltage. It can be fairly claimed that central station managers operating direct-current generators have given the subject of voltage regulation much closer study and are furnishing current at more nearly uniform pressure than is supplied from alternating-current stations. This is probably due to the fact that in the direct-current station the loss in pressure at full load from generator to lamp is usually about twenty per cent, while in the alternating plant the loss is about ten per cent. The high loss in pressure in the direct-current plant has necessitated the use of feeder regulators and pressure wires run from centres of distribution to all meters at the station, so the station attendant can constantly adjust the feeder regulators so as to maintain constant pressure at the centres of distribution. This plan of operation has given such good results that it has been found possible to use high-efficiency lamps requiring 3.1 watts per candle-power instead of 3.6-watt lamps as formerly used. In the alternating-current plants, on account of the smaller drop in the feeders, pressure wires, centres of distribution and feeder regulators are rarely used, it being generally assumed that five or ten per cent variation does not affect the operating of a plant materially. The majority of the alternating plants are still using lamps, taking 3.6 watts per candle-power.

If the customers' circuits were supplied with current of constant pressure the output in incandescent lamps could be increased 13.9 per cent.

The extensive and growing use of curve-drawing instruments has disclosed how variable the pressure is in most of the central stations of the country. No central station manager should be without one or two of these instruments. Before attempting to regulate the pressure at centres of distribution by means of feeder regulators, the main source of supply should be maintained at the proper pressure. The pressure at the generator must vary with the load in order to overcome line losses. Generators are usually constructed to give ten per cent higher pressure at full load than at no load. The voltage of a generator is greatly affected by the speed and by temperature changes.

The first type of regulator for generators was the automatic rheostat of Mr. Edison's, which was used with shunt-wound, direct-current generators fifteen years ago. This was used about five years when its manufacture was discontinued in favor of the compound-wound machine. The advantage of being free from change in voltage, due to change in speed and temperature, was not sufficient to overcome the higher cost as compared with a compound-wound machine. This type of regulator to be used with modern machines is not a success owing to its inability to control the voltage quickly enough. In order to vary the voltage quickly the rheostat arm would have to move a considerable distance instantly, and regulators of this type have failed to control the voltage as the service demanded. The compound-wound generator does not give proper voltage when its speed is changed, and the compound winding does not correct for temperature effects. A generator regulator of novel design has recently been invented by Mr. A. A. Tyrrell. Two types have been designed—one to be used with direct-current generators, and the other for alternating-current generators. These regulators control the voltage of the generators by closing and opening a short-circuit around the field rheostat, thus cutting in and out the resistance in the field circuit of the generator, the voltage being varied by the length of time the resistance is included in circuit and out of circuit. This operation is made at a high rate of speed, varying from 50 to 800 times per minute. The movement of the contacts which switches in and out the resistance is accomplished by a relay, the motion of the contacts being about one-sixteenth of an inch.

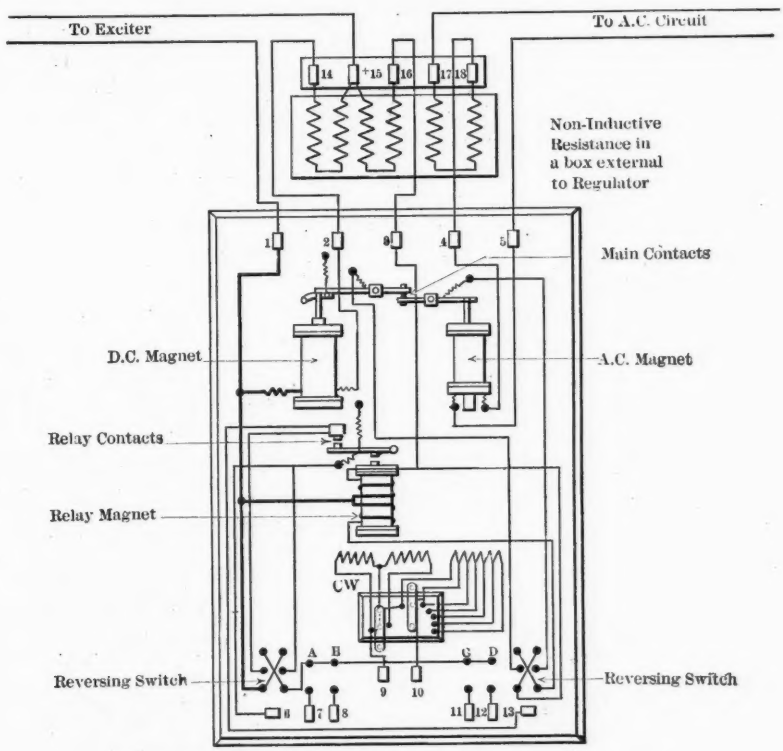
On the board equipped with the direct-current regulator a control magnet is placed on the left side of the board and connected across the circuit, the voltage of which is to be regulated. A relay is located at the middle of the board. The movement of the contacts of the control magnet causes the relay contacts to open and close. The relay contacts are connected to the terminals of the field rheostat of the generator. When the relay contacts are closed the field rheostat is short-circuited, which cuts out the resistance and so causes the generator to give its highest voltage. When the relay contacts are open all the resistance of the field rheostat is inserted in the field circuit of the generator and so causes it to give the lowest voltage, so by rapidly closing and opening the relay contacts the voltage of the generator is maintained at a constant value. This operation is done at about 800 times per minute. A condenser is connected to the relay contacts to prevent the injurious sparking. The control magnet is connected by means of pressure wires to the centre of distribution. A curve-drawing voltmeter when connected to a circuit, the voltage of which is controlled by one of these regulators, will show a record as straight as if ruled with a straight edge.

The voltage of the alternating-current generator is controlled by varying the resistance in the field of the exciter.

The regulator for the alternating-current generator is similar to the direct-current regulator with the addition of another control magnet which is connected across the exciter circuit. Opposite is an illustration showing the regulator for alternating-current generators. The magnet on the left is the direct-current control magnet which is connected across the exciter circuit, while the magnet on the right is the alternating-current control magnet which is connected across the circuit to be regulated, while the relay is in the centre of the board. The alternating-control magnet has two windings, one which is connected across the circuit to be regulated, the other which is connected to a series transformer. The function of the second winding is to build up the generator voltage in direct proportion to the current in line and thus compensate for the loss in the line. The compounding effect can be varied by means of two levers swinging over contact points which cut in or out various turns on the magnet. Once the regulator is adjusted it will maintain constant potential at a centre of distribution without any hand adjustment irrespective of the character of the load. The regulation is not affected by speed changes unless the speed is so low that the voltage could not possibly be maintained. The alternating-current and direct-current control magnets together operate a pair of contacts known as float-

*Abstract of paper read before Northwestern Electrical Society, January 12, 1908.

ing contacts, which operate the relay magnet which opens or closes the shunt circuit across the exciter field rheostat as in the direct-current regulator described above. The function of the floating contacts is to so actuate the relay magnet that the voltage is maintained under all conditions of exciter and alternator voltages. These contacts bring together the alternating-current and direct-current portion of the regulator and control the voltage of both simultaneously. These contacts will usually raise from no load to full load about three-thirty-seconds of an inch, while the exciter voltage may vary from 10 to 130 volts in order to maintain the desired alternating voltage.




AUTOMATIC VOLTAGE REGULATOR—DIAGRAM OF CONNECTIONS.

One regulator will regulate any number of generators of any kilowatt capacity providing they are all running in parallel and the exciters are also in parallel.

The voltage regulators referred to in the early part of this paper are designed to control the voltage of the generators. These regulators may be controlled by pressure wires brought back from a centre of distribution, but as the distribution system from a central station is usually laid out for several centres it is necessary to have means of automatically adjusting the voltage for additional centres of distribution.

For this purpose the automatic feeder regulator for alternating-current generators has been developed. It is usually customary to allow considerable drop in pressure from the central station generator to the incandescent lamp or other translating device. Frequently this drop amounts to ten per cent of the initial voltage. With such a drop, which varies according to the load, it is manifestly necessary to frequently adjust the voltage at the central station in order to keep it at a uniform voltage at the centre of distribution. At the present time this is generally accomplished by means of hand regulators, and therefore it is only imperfectly done. An automatic feeder regulator will do the work much more accurately and more cheaply than an operator with a hand rheostat.

The alternating-current feeder regulators have been made in two types, one a booster transformer or the induction type, which is similar to the well-known constant transformer used with series arc lamps, the movement of the coils being accomplished by compressed air operating on a piston and cylinder, the movement of the coil being controlled by a voltmeter. This type of regulator has the advantage of having no contacts, and the voltage can be very gradually varied. This type is recommended to be used in connection with generators.

Where a transformer is used in connection with a transmission plant stepping down the voltage from, say, 10,000 to 2,000, a dial switch can be placed upon the transformer. The contacts can be arranged so that a portion of the winding can be cut off, thus the secondary voltage can be varied at will. The movement of the switch arm is controlled by a voltmeter, a motor furnishing the power necessary to move the switch. The voltmeter operates magnetic clutches which apply the power to the switch. The advantage of this type of regulator over the induction type is somewhat lower than first cost. The disadvantage is that the voltage has to be varied by different steps depending upon the number of contacts employed. Usually a difference between steps of one volt is used, and unless a large number of contacts are provided, which would make the apparatus probably too expensive, a variation of a volt is a little too great for the best work, therefore the induction type regulator has advantage over the dial switch type.

Regulators of the above types have been used in connection with water-power transmission plants, as in such cases the drop of pressure in lines is frequently very great and the variation in voltage considerable. There seems to be a large field for the use of such regulators. In some water-power transmission plants the variation in voltage at times has been as much as twenty per cent, which gives very unsatisfactory service to the consumers. An installation of these automatic feeder regulators has corrected the trouble and maintained almost constant voltage so that the service is satisfactory.

## *Fault Localizing on Tramway Systems.*

Mr. A. H. Johnson in a British contemporary describes a system for locating faults on railway cables. This system requires a small conductor to be laid with and connected to the far end of each cable. In the event of the breakdown of any cable, the station end of this pilot wire is connected through a suitable voltmeter to the bus-bar on the switchboard. Then a known current is sent through the faulty cable. The voltmeter will read the drop of potential from the switchboard to the fault, and if the resistance of the cable is known, the defective point is at once determined. For convenience it is advisable to install on the switchboard an auxiliary bus-bar for making these tests. Connecting between this and the main bus the artificial load, and using double-throw switches, any feeder can at any time be tested. The system is applicable even when the trolley wires and feeders are connected in parallel.

### *Dinner of the American Institute of Electrical Engineers.*

A second annual library dinner of the American Institute of Electrical Engineers took place Monday evening, February 9, at Sherry's, New York city. The attendance was good, there being nearly 300 members and guests present. The guests of honor were Mr. Andrew Carnegie and Dr. Schuyler S. Wheeler, in recognition of their liberal donations to the Institute library. In extending a welcome to the members and guests, President Charles F. Scott spoke of the dinner given last year to Mr. William Marconi who had just succeeded in sending a message by wireless telegraphy across the Atlantic, and the reception given to Lord Kelvin, who is indellibly connected with first signaling across the ocean. It is notable that before the Institute celebrated a second library dinner, complete messages had been transmitted across the ocean by the new system. Thus wireless communication has been successfully established after about one year's work, while it took eight to ten years to secure practical service after the first message had been sent over the cable. The contrast illustrates by the changed conditions—things move faster in these days. Progress and activity mark every department of life—scientific discovery, invention, engineering development—all these underlie the awakening of recent years.

Mr. Scott emphasized the magnitude of the work which devolves upon the youngest of the professions and the need of developing effective and efficient methods. With few exceptions the electrical enterprises of the present day, in which $4,000,000,000 of capital is invested, have grown up within the past fifteen or twenty years. Progress has been rapid; but one set of problems is scarcely made before new requirements arise. This point is illustrated by the changes in transportation methods. The old horse-car system was replaced by the cable, but the work of transformation was not complete before the electrical system began to take its place. This was followed quickly by the transformation of the heavier traffic on the elevated roads from steam to electricity, and before that work had been finished work on the rapid transit system is started with heavier trains and higher speeds, and long before this system is ready to start, the Pennsylvania terminal is undertaken for trains operating under the steam railway conditions.

Electrical advance has called for larger and heavier apparatus to cooperate in larger and more complex systems, and there has been a demand for men, for more men, for larger men, for men to devise, to undertake, to execute. Responsibilities of increasing magnitude confront the electrical engineer.

Mr. Scott considered the Institute of Electrical Engineers as a definite, positive force for the advancement of the electrical engineering profession and its work. If asked to state briefly the effect of electricity he would reply, "Electricity means efficiency." By its use the world's work may be done more quickly and at less cost. The telephone is an instantaneous messenger which doubles the work a man can do. The railway motor, the motor in the mine, the crane motor, the motor in the machine-shop, bring results more quickly and more cheaply. Electrochemical processes produce cheaper products. The electric light adds to the hours of the efficient activity. Electricity has given to the whole world a new method of doing things, of doing them more efficiently in time and in cost. The profession of electrical engineering is not narrow, as there is no other that touches modern lines at so many points. The speaker then spoke of the desirability of increasing the membership of the Institute. He did not think an extension of membership would compromise the dignity or lower the standards. There are two classes of membership of which full membership should be exclusive—associate membership inclusive. He spoke of the benefits which have already come from the work of the local chapters. This work has been taken up enthusiastically in various cities and colleges, and has resulted in an increased interest in Institute matters.

Mr. Scott spoke of the influence upon electrical progress and the work of the Institute, and showed how this was being extended. He was looking forward to the time when a building suitable to the dignity and demands of the society might be secured. The speaker then made a plea for cooperation in the work of building up the library. Through the generosity of certain members and others an excellent start has been made. It would be difficult to overestimate the value of a good library. An English engineer, in referring to the development of the American iron and steel industry, makes this statement: "The most remarkable and industrial development in the history of iron-making is mainly the result of two factors—the popularization of practical science by the American scientific journals and the courage and inventive genius of the American iron masters." It is very fitting that the means for making the Institute library more useful should have been contributed by the man so highly appreciative of libraries—Andrew Carnegie.

Mr. Scott was followed by Mr. Andrew Carnegie, who gave an interesting account of his early work, showing how in his youth he had been a worker in the only electrical industry at that time existing—the telegraph. Mr. Carnegie was very appreciative of the work of the electrical engineer. He praised highly American methods, but claimed some credit for the Scotch engineers, Watt, Stevenson and Fulton. He attributed much of the development in this country to republican institutions.

Mr. Carnegie was followed by Dr. Wheeler, who described the extent and value of the Latimer Clark library, which he has presented to the Institute. Dr. John S. Billings spoke of the technical library. Mr. R. R. Bowker, "The Unity of Science;" Mr. Theodore De Vinne told of "The Debt of Mechanics to Science," and Dr. J. C. Bayles dwelt on "Electricity and the Daily Press."

The room was tastefully decorated with festoons of electric lights, furnished by Mr. Russell Spaulding, president of the Elblight Company of America, the current for these being supplied by the New York Edison company. Among those present were B. J. Arnold, W. S. Barstow, R. R. Bowker, J. C. Bayles, Charles Blizard, N. F. Brady, C. A. Bragg, J. C. Barclay, Charles S. Bradley, E. G. Barnard, F. B. Crocker, Louis Duncan, Thomas A. Edison, John Fritz, W. E. Goldsborough, Wilson S. Howell, W. J. Hammer, C. W. Hunt, Ray D. Lillibridge, J. W. Lieb, Jr., E. H. Mullin, Thomas E. Murray, R. W. Pope, C. W. Rice, Fred A. Scheffler, William Stanley, George F. Sever, F. J. Sprague, Charles A. Terry, A. A. Thresher, Elihu Thomson, A. J. Wise, E. L. Zalinski, Wm. Hand Browne, Jr.

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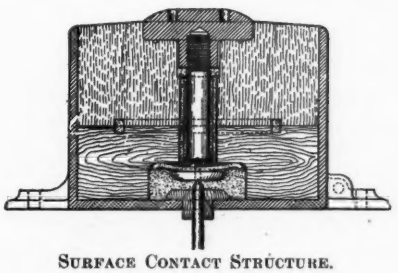
By an official change in the running time of the Southern Express, the flyer on the Orleans Railway, of France, the Empire State Express of the New York Central & Hudson River Railroad has regained its lost title of the fastest train in the world. For some time past the speed of the Southern Express, which runs over the Orleans Railway between Paris and Bayonne, has been fifty-four miles an hour. The Empire State Express made its schedule run from New York to Buffalo, a distance of 440 miles, in eight hours and fifteen minutes, the average speed being fifty-three and one-third miles an hour. By the new arrangement the Southern Express attains an average speed of forty-nine and three-tenths miles an hour.

# Electrical Patents.

Mr. Edward M. Hewlett, of Schenectady, N. Y., has assigned to the General Electric Company a patent he has procured on a surface-contact structure for electric railways of the type wherein the conductor engaged by the collector on the car is divided into insulated sections formed of studs or buttons exposed in the roadway. A metal casing is employed, which is adapted to receive the operative parts of the structure and is provided at its lower end with outstanding ears having bolt holes, whereby it may be secured to a suitable support in the roadway, such as the wooden cross-ties. The casing is provided with a hole in its bottom for the reception of a bushing of suitable insulating material through which is passed the lead. This lead is connected to the feeder or main, preferably through an electromagnetically actuated switch which may be of any desired construction. The lead extends through the bushing into the interior of the casing and is connected to the lower end of a bolt inserted head downwardly in the casing and having its upper end screw-threaded. The lower end of the bolt next to its head is angular, and fitted thereon is a leaf spring. Blocks of suitable insulating material, preferably wood, are next inserted in the casing, so



SURFACE CONTACT STRUCTURE.

as to completely fill the same. These blocks are formed with upper and lower recesses, which communicate with each other by a groove through which the bolt passes, this groove, however, being of greater diameter than the bolt. After the blocks are inserted in the casing, the lead having been attached to the bolt, a suitable plastic insulating compound is poured into the groove so as to completely fill the lower recess and the groove. A surface-contact stud adapted to be engaged by the car collector and interiorly screw-threaded, is next screwed on the upper end of the bolt, serving to draw the same upwardly, thus bending the spring and preventing the bolt from turning, while securing the contact stud. The insulating filling soon hardens, so as to rigidly support the bolt in place entirely independently of the stud, which can be readily removed by unscrewing it when it becomes worn by the engagement of the collector shoes carried by the cars. It will be seen that the use of the insulating filling prevents the access of moisture around the studs from the roadway to the lower recess, where a short-circuit to ground might take place from the lead or the bolt to the metal casing. Furthermore, the insulating filling in the lower recess insulates the lead, the bolt and the spring from the metal casing to prevent a similar short-circuit.

The Chase-Shawmut Company, of Boston, Mass., controls a patent recently issued on an electric fuse or cutout, which is the invention of Harry L. Morse, also of Boston. The object is to provide a novel indicating device adapted to be

ELECTRIC FUSE OR CUTOUT.

operated by an increase of pressure within the shell or case containing the fuse or other wire to indicate that the same has been ruptured; also to provide a novel gas-producing element which is contained in the shell or case and adapted to be ignited by the arc produced by the rupture of the fuse wire, whereby the pressure within the shell or case is increased. This shell or case is preferably in the form of a cylindrical tubular body closed at its ends by caps and filled or packed with asbestos, mica or other refractory material. It is furthermore provided with an opening across which is secured a flexible piece of foraminous material, such as cotton cloth, which is secured to the inside of the shell and made of suitable size to more than cover the opening. Under normal conditions this cloth is pressed inwardly and therefore projects more or less into the shell, yet, being flexible, is capable of being pressed outwardly through the hole, and thereby caused to project so that it can be readily seen. The leads pass through the end caps and are connected by a suitable fuse wire. They are also preferably connected by a small shunt wire, though this may be omitted if desired. Arranged directly over the fuse wire and preferably secured to the shunt wire is a gas-producing element, such, for instance, as picrate of potassium, which is contained in a suitable capsule. In operation, the gas-producing element is ignited by the arc produced by the rupture of the fuse wire, and the gas generated will cause an increase of pressure within the shell. As a result, the cloth indicator will be blown outwardly and thus being exposed will show which case contains the blown fuse.

## *Sale of the Stanley Electric Manufacturing Company.*

The announcement was telegraphed from Pittsfield, Mass., on Wednesday of this week that the sale of the Stanley Electric Manufacturing Company to several capitalists identified with the General Electric Company had been consummated, the Messrs. F. W. Roebling and F. A. C. Perrine retiring. It is understood that the Stanley company will continue to manufacture in Pittsfield on an expanding scale.

## *WISCONSIN TELEPHONE ASSOCIATION.*

ANNUAL CONVENTION IN MILWAUKEE.

The Independent Telephone Association of Wisconsin met in annual convention on Wednesday of this week at the Hotel Pfister. Everyone was quite enthusiastic over the important progress made by the association. The manufacturers were strongly represented, and there was a fair attendance of operating companies.

President Richard Valentine, of Janesville, Wis., in his annual address referred to the splendid progress of the association during the past year. There are now 200 independent exchanges in the state, 1,000 toll stations and 30,000 subscribers. He discussed also the Berliner patent suit.

Among the firms represented were: The Kellogg Switchboard and Supply Company, by R. Manson, G. L. Ainsworth; Farr Telephone Company, Chas. W. Farr; Western Telephone Construction Company, J. E. Keelyn; Vought-Berger Company, La Crosse, M. T. Berger, C. M. Daugherty; Stromberg-Carlson Company, J. J. Nate, A. S. Munsell; American Electric Telephone Company, Max W. Zabel, H. P. Blacklege; Holtzer-Cabot Company, Boston, E. R. Harding, T. M. Meinema; Automatic Electric Company, J. F. Crook; Lindsley Brothers Company, E. A. Lindsley; American Fuse Company, Frank J. Jones, J. J. Kenney; Electrical Appliance Company, S. A. Densmore, J. B. McMullin; Standard Telephone Company, Madison, J. H. Parish, W. A. Taylor; Sterling Telephone Company, La Fayette, F. E. Rotchka, Clyde Dunseth; Chicago Telephone Holder, F. W. Pardee; Chicago Pay Station Company, J. C. Finch; Standard Underground Cable Company, E. T. Pietscker, J. R. Wiley; M. B. Austin Company; F. Bissell Company, Toledo; Illinois Electric Company, N. G. Harvey, C. W. Bacon, C. L. Pierce, Jr.; Illinois Electrical Specialty Company, F. B. Patton; Green Telephone Company, Milwaukee, J. H. Green; Eureka Electric Company, J. J. Kusel; Julius Andrae, Milwaukee, J. C. Schmidtbauer, H. J. Meyer, F. T. Andrae; Chicago Telephone Supply Company, Elkhart, S. A. Duvell; John A. Roebling's Sons Company, Geo. C. Bailey; Bell of Baraboo.

# Reviews of Current Engineering and Scientific Literature.

### *Railway Train Lighting by Electricity.*

This is a description by Mr. G. H. Dowling, of Stone & Company's system of lighting railway trains by electricity. The generator is a shunt-wound machine with ring armature, and has an output of thirty amperes at twenty volts. It is suspended by links from the car sills, and driven from the axle by means of a belt. The pole-changer operates by friction, and in its motion to the right or the left makes successive contacts on the dynamo switchboard. The first contact connects in the field of the generator and brings the machine up to full excitation, so as to prevent a heavy rush of current at the moment of cutting in the armature, which is effected by the next movement of the switch. This switch is operated by a centrifugal governor, throwing the switch arm to the right or left according to the direction of the car. The switch arm, which is normally held in the off position, is thus acted upon by a force proportional to the speed of the car, the final connection being made when the car has attained a speed of ten miles an hour. Regulation of the generator is effected by allowing the belt to slip. The generator, when in action, charges two batteries of accumulators from which circuits are run to the lamps. The author concludes his paper by a summary of the troubles met with in operating a system of this character, and suggests remedies for these.—*Abstracted from the Electrical Engineer (London), January* 23.

### *Electromotive Force in Plants.*

Mr. A. B. Plowman has made a careful study of the electromotive forces set up within living vegetable matter. The first systematic study of the electrical properties of plants was made by J. B. Sanderson. His work, which was carried out with much care, has been gone over by the author, and his conclusions, in the main, verified. In this work care must, of course, be taken to prevent the introduction of other sources of electromotive force, particularly as the values to be measured are very minute. It is also necessary to prevent injury to the plant in this study. The conclusions arrived at by the author may be summed up as follows: The functional activities of a plant give rise to conditions of electrical potential in its parts, the intensity and relative sign of which depends upon the physiological condition of the plant, as well as its electrical conductivity. The normal electromotive force in a plant may be modified by a brief application of forced currents, this result apparently being due in part to a change in resistance, and in part to a modification in the vital activity of the protoplasm. Slight mechanical injuries do not perceptibly modify the normal current, but extensive mechanical injury or high temperature destroys this. Extensive injuries to a plant excite an electromotive force spreading from the point of injury through the tissues.—*Abstracted from the American Journal of Science (New Haven), February.*

### *Static Electricity Applied to Ore Dressings.*

In this article Mr. W. G. Swart gives some interesting figures of the operation of the ore separator invented by L. I. Blake and L. N. Morscher. The method used in this machine consists in bringing the mass of ore particles into contact with a statically charged metallic surface. Such particles as possess relatively high conductivity are instantly repelled, while those of low conductivity are not repelled until sufficient time has elapsed to allow them to be pulled out of their original path and caught in a separate receptacle. In developing this apparatus much original work has been done toward applying static electricity to practical use. The inventors have developed a static generator of improved pattern, and by careful experimentation and study have been able to reduce the necessary voltage from 250,000 to from 10,000 to 20,000. The separator used in these tests was a double one, twenty-four feet in length, forty-one inches wide and eighty-one inches high. One horse-power was required to drive this, this figure including the power consumed by the static generator. In one experiment a zinc ore which was passed through had originally less than fifty per cent of zinc, but the separated material contained over sixty per cent of zinc. Another ore passed through, containing originally about thirty per cent of zinc, contained after separation over fifty-one per cent of zinc. One of these machines has been working steadily at the Colorado Zinc Company's plant, Denver, Col., doing this character of work.—*Abstracted from the Mining and Scientific Press (San Francisco), January* 24.

### *The Electrical Operation of Cotton Factories.*

This article by M. J. Montpellier first discusses the general advantages of electricity for weaving mills, and then considers the specific case of the Société Cotonniere at Mirecourt, France. To operate this factory machanically, a 500-horse-power steam engine making seventy-five revolutions per minute would be required. Power from this would be transmitted by ropes and gears to the various line shafts throughout the mills. By employing electrical transmission instead of mechanical, a higher speed, and therefore cheaper, engine could be used, and the transmitting ropes, belts and gears would be done away with. The estimated cost for the first method was $31,088 (155,440 francs). An electrical transmission system for the same work would cost $30,488 (152,440 francs). From this it appears that the electrical system would be so much cheaper than the mechanical. Comparing the efficiencies of the two systems, again the electrical is found to be the better. The efficiency of mechanical transmission is given as 66.8 per cent; for electrical transmission the figure is 71.7 per cent, or about five per cent better than the other. There is, moreover, a considerable reduction in the cost of maintenance of the belts, ropes and gears, and ill effects of weather on the ropes are removed. In the electrical system adopted the lines of overhead shafting were retained. These were divided into pairs, each pair being driven through belts by one motor. In the carding and spinning mills the motors are installed in small bays thrown off from the operating room, and thus do not encumber the main floor. This installation has been operating very successfully, and all the advantages expected have been obtained.—*Abstracted from L'Electricien (Paris), January* 17.

### *The Electric Lighting of Erith, England.*

The new lighting station of Erith was recently put into service. As the district here is somewhat scattered, and there is some demand for power, a high-voltage, three-phase system was installed. Current is produced at 3,000 volts and conveyed to certain points in the supply area, where it is transformed down to 200 volts for lighting and 350 volts for power. The station is conveniently located with respect to coal and water facilities, and the

building arranged to allow for extensions and the introduction of a possible dust destructor. The boiler-house equipment comprises two Lancashire boilers, delivering steam at 160 pounds, and a Green fuel economizer, two feed pumps being provided, one electrically driven. There is also a surface condenser. The engine-room equipment consists of two 125-kilowatt steam alternators directly coupled to vertical compound self-lubricating engines. The speed of the large sets is 375 revolutions per minute, and of the small set, 500 revolutions per minute. The alternators are of the revolving field type, the poles being composed of cast steel. The armature coils are star-connected. The current density in the armature is less than 2,000 amperes per square inch, and in the field magnets less than 1,000 amperes per square inch. The frequency is fifty cycles per second. Each alternator is fitted to a direct-driven six-pole or four-pole shunt-wound exciter. The switchboard is arranged for three alternators and exciters, and four outgoing circuits, and permits any alternator to be coupled separately to any circuit No part of the front of the board carries a high pressure. There are two switchboards—one mounted behind the other, one carrying the switch handles, recording instruments and synchronizing gear, while the one in the rear carries the gear for the outgoing cables. The lines to the distributing mains are three-core, paper-insulated, steel-armored feeder cables, laid in wooden troughing, filled in with refined Trinidad bitumen, and covered with tiles. The distributing mains are two, three or four-core cables.—*Abstracted from the Electrical Review (London), January* 16.

### *Electrical Pumping Installation.*

Electrical pumping in mines has scored a number of successes in the last few years. In this article M. J. Loubat describes the pumping plant of the de Roche-la-Moliere et Firminy, France. The generator is directly connected to a Corliss engine, the speed of which can be varied from 50 to 100 turns per minute. The engine is rated at 300 horse-power at 100 turns. The generator delivers three-phase current at 1,000 volts and a frequency of twenty periods per second at a speed of 100 turns per minute. The stationary armature is wound with seventy-two coils, each consisting of six conductors, and each conductor being made of three wires in parallel, the diameter of each wire being 4.8 millimetres. The revolving field has twenty-four poles, and the exciter is coupled directly to the generator shaft. The pump, which is located in a chamber in the mine, is directly driven by a 200-horse-power, three-phase induction motor making 100 turns per minute and taking current at 970 volts, twenty cycles per second. The diameter of the stator is 1.8 metres. It is wound for twenty-four poles, having 216 slots, or three slots per pole per phase. Each slot contains five conductors, each conductor being formed of three wires in parallel, 4.8 millimetres in diameter. The rotor contains 288 slots or four slots per pole per phase. Each slot contains a conductor formed of twelve wires in parallel. The diameter of the rotor is 1.797 metres. The work of the pump is varied by varying the speed of the engine at the station. Two governors are provided—one controlling the speed between fifty and seventy turns per minute, and the other all speeds above. Tests of this motor, made before installation, show an efficiency of about ninety-five per cent, and a power-factor at full load of eighty-five per cent. The efficiency of the generator is given as ninety-three per cent at full load. The losses in the cables are estimated at two and one-half per cent, making the total efficiency of the installation eighty-five and two-tenths per cent.—*Abstracted from the Revue Technique (Paris), December* 25.

### *Negative Boosters.*

In this communication the author, whose name is not given, considers the application of negative boosters to railway work. In Great Britain the Board of Trade regulations limit the allowable drop of potential between any two points of the track to seven volts, so that the use of boosters has been necessary in many cases. The author considers specific cases, and shows the action of the booster very clearly. No economy is obtained by their use. In fact, they cause a greater loss of energy. In a case given, the loss in the booster and cable was over nine times that in the rail, being considerably more than would have been the case had the booster not been installed. Boosters may be excited in a number of ways: First, by a shunt circuit between the trolley and the track. This method is not automatic. The load on the booster is independent of the load on the station. Regulation must be effected by hand, and at periods of light load the booster is simply wasting energy. A second method uses a series machine. This is but slightly self-regulating, and usually calls for a shunt-regulated resistance in parallel with the field winding. A third method connects the field of the booster in series with the rails. This arrangement is automatic, but is not suitable for systems where the tracks branch in several directions. The best method is to connect the field of the booster in series with a positive feeder, running to the same point as the booster cable. The loss of pressure in the trolley wire and the rails will be approximately proportional, and the arrangement is self-regulating. The author then gives a method for determining the proper location of booster cables. A chart is constructed, showing the worst position of the cars, the current taken by each, and the distances from the power-house. Knowing the rail resistance, the drop in potential per yard can be calculated, and the point found where a booster cable will be needed. The method is made clear by a numerical example.—*Abstracted from the Tramway and Railway World (London), January* 15.

### *Discharge in an Electric Field.*

When a spark-gap is immersed in a transverse electrostatic field the discharge potential is reduced. M. Cantor, from whose researches this is known, has also found this is the case, not only when the field is steady, but when it is alternating. The alternating field was produced by a condenser fed by an induction coil. The wire conveying the condenser discharge was attached to a tube which contained the spark-gap to be studied, and it was found that the discharge potential of the latter fell from 3,200 volts to 2,200 volts. In another experiment two copper discs 100 millimetres in diameter were mounted at a distance of forty millimetres apart and insulated. One of them was then connected with the wire conveying the alternating discharge, while the other was connected with the knob of an electroscope. A positive charge of the electroscope was maintained intact, but a negative charge was quickly dissipated. All this was observed without the trace of a discharge between the plates being observed. No difference was made, indeed, by introducing a slab of paraffin between the plates.—*Abstracted from Electrical Engineer, London.*

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Brittle copper when heated to redness becomes soft and is said to be "annealed," whether cooled quickly or slowly. Commercial copper usually contains small amounts of silver, arsenic, bismuth, iron and other metals, but is pure enough for most practical purposes.

# INDUSTRIAL SECTION.

*ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.*

## *Revolving Fan Motors for Alternating and Direct Currents.*

While the fan motor has been for some time recognized as a very necessary piece of apparatus, there has been more or less

FIG. 1.—ALTERNATING-CURRENT REVOLVING FAN MOTOR.

adverse comment on the use of electric fans, due to the current of air being projected in a single direction. To obviate this alleged inconvenience there have been from time to time adaptations whereby the current of air might be projected over broader ranges of air space. The accompanying illustrations show a motor which has been designed to automatically distribute an even current of air to all parts of a room. This consists of a spherical enclosed motor suspended from a ball-bearing so as to revolve around a vertical axis. The case of the motor is small and of light weight, being three and five-eighths inches in diameter and cast of aluminum. The shaft of the motor upon which the fan is mounted is

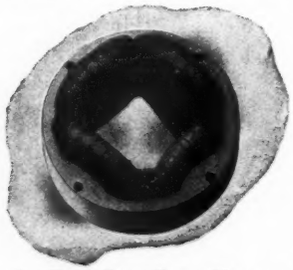


FIG. 2.—FOUR-POLE FIELD MAGNET FOR 140-CYCLE MACHINE.

placed at an angle of forty-five degrees to the vertical axis of the complete structure. The result is that since the top fan blades are farther from the centre of rotation than the lower blades an unbalanced condition is produced which causes the motor to revolve in a horizontal plane, distributing, at intervals, the air to all parts of the room.

Fig. 1 shows a new type of alternating-current revolving fan motor. These motors are built for either 60 or 140-cycle,

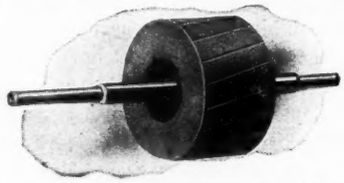


FIG. 3.—INDUCTOR ARMATURE FOR 140-CYCLE MACHINE.

50 or 100-volt alternating current. The 140-cycle machine is made of the induction type, and is provided with a four-pole field magnet, Fig. 2, built up of punched and japanned laminations. The armature, Fig. 3, is of the squirrel-cage construction with laminated core, the conductors consisting of uninsulated copper rods which are placed in slots crossing the core diagonally.

The low-frequency motor is of the commutator, instead of the induction type.

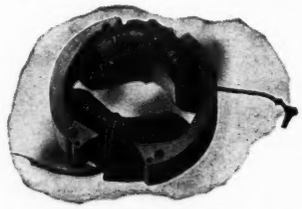


FIG. 4.—FIELD MAGNET FOR LOW-FREQUENCY MACHINE.

The field magnet, Fig. 4, and the armature, Fig. 5, are laminated.

The armature core discs or laminations are twisted so as to make the slots into which the windings are placed diagonal to the face of the core, the object of this being the same as in the 140-cycle machine.

The carbon brushes are of rectangular cross-section and mounted in brass tubes into which they fit closely. The brushes are pressed against the commutator by springs which are contained in the tubes immediately back of the brushes, as in the ordinary cartridge type of brush-holder. The spring tension, however, is adjustable by means of screws in the back ends of the brush-holders. This construction is shown in Fig. 6.

The bearings are of the self-oiling type and are very durable, being cast of magnolia metal under heavy pressure. They are provided with felt oil retainers, so that one oiling will last for a great length of time. The bearings are constructed so that they can be quickly replaced should they become accidentally damaged.

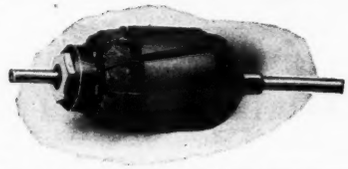


FIG. 5.—ARMATURE FOR LOW-FREQUENCY MACHINE.

In the direct-current motor the suspension ball-bearing, shaft-bearings, position of shaft with reference to the vertical axis of the structure, and the method of leading in the current to the motor terminals are the same as in the alternating-current machine. The field mag-

FIG. 6.—BRUSH ADJUSTMENT AND TENSION SPRING.

net is built up of punched and japanned laminations, the armature being drum-wound and the windings placed in slots diagonal to the surface of the armature core. The brush-holder mechanism is identical with the brush-holder mechanism of the sixty-cycle alternating-cur-

FIG. 7.—DIRECT-CURRENT REVOLVING FAN MOTOR.

rent fan motor described above, and in appearance these are practically the same. Fig. 7, however, shows the appearance of the direct-current revolving fan motor.

These machines are manufactured by the Fort Wayne Electric Works, Fort Wayne, Ind.

### *Special Clay Products.*

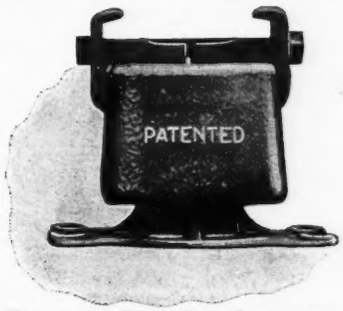
The many large developments which are under way in the form of subways and electrical railway systems have drawn attention to the great increase which recent years have brought in the use of special clay products.

One of the most successful uses to which clay has been put is in the manufacture of conduit for underground construction and insulating blocks for third-rail systems. The adaptability of vitrified salt-glazed clay in these services is readily conceded.

At South River, N. J., the Standard Vitrified Conduit Company has in operation one of the largest and most modern works for the production of vitrified salt-glazed clay products in the world. In conduit alone the capacity of this works is 25,000,000 feet annually. Approximately, 18,000,000 feet of conduit were used in the United States last year. According to these figures this works has sufficient capacity to supply the entire needs of the country.

The accompanying illustration, Fig. 1, shows the standard form of third-rail insulator manufactured by this company. This insulator is the invention of Mr. Patrick S. Haley, superintendent of the Chicago Electric Railway, and the patent was granted on July 7, 1896. Dating from December 12, 1902, the life of the patent is controlled by the Standard Vitrified Conduit Company. This insulator consists of a malleable iron stool, over which is fitted a petticoat of vitrified salt-glazed clay. Fastened to the top of this insulating block, as may be seen from the engraving, is a suitable clamp which is connected by a threaded bolt which securely grips and holds the flange of the rail. The recent troubles which some of the elevated railroad companies have experienced with reference to the lodgment of sleet and ice during severe storms may possibly necessitate the construction of a different form of rail. This company now controls a number of clamping devices which will adapt this insulator block to any conceivable departure of rail construction.

This insulator has been made the subject of some very interesting tests as to its electrical and mechanical qualities. One test, submitted by Mr. Hugh Hazleton, electrical engineer of the Manhattan Railway Company, shows that the resistance of a dry insulating block varied between 9.8 and 10 megohms. The resistance of a wet insulating block varied between 77,800 and 126,000 ohms. A breakdown test, dry, gave 15,500 to 16,000 volts. Another recent test gave a breakdown result of 13,000 volts alternating current when dry, and 10,000 volts alternating current when wet. The leakage of current at 530 volts direct current was unappreciable when dry, and ten milliamperes when wet.




MANHATTAN THIRD-RAIL INSULATOR.

In Fig. 2 is shown the result of a breakdown test for mechanical strength.

AN INTERESTING RESULT OF A TEST FOR PRESSURE RESISTING QUALITY.

It will be noted that the malleable iron stool has been bent, and the hardwood plank upon which it rested has been split and indented. This test was continued to a point where the petticoat had been entirely broken away and the portion between the point of pressure and the iron stool still remained intact. This pressure was stopped when an application of 51,000 pounds had been applied. A note might be made here of a similar test made by Dr. McKenna about a year ago. This test was made on a third-rail insulator made of fire-clay, this standing a crushing test of 19,500 pounds. Since this time these insulators have been made of pure stoneware clay, with the result above stated.

The malleable iron castings for the stools are made by the Malleable Iron Fittings Company, of Branford, Ct. Owing to the magnitude of this company's plant and the facilities for making the best castings, this part of the device has been found to be absolutely satisfactory in service.

The use of this insulator has been very great, and the anticipations of the company are that it will have a very much greater use in the future. Eighty thousand of these have been supplied to the Manhattan Railway Company, of New York, and have been successfully installed. As the general characteristics of all of the lines now being laid down by the Interborough Rapid Transit Company will partake of this same construction, it is very likely that this form of insulator will be used on all of the third-rail systems of the continuous network of tracks, the ramifications of which will enter New Jersey, New York and Long Island.

These insulators are also favorably regarded by a number of other large installing corporations, notably a seventy-mile third-rail proposition in Ohio; and, abroad, the chief engineer of the Yerkes railways in England, and the engineering department of Robert W. Blackwell & Company, of Paris.

Mr. R. W. Lyle, president and general manager of the Standard Vitrified Conduit Company, is one of the foremost workers in the manufacture of clay and pottery-ware. Mr. Lyle's experience in the manufacture of these products has extended over thirty-five years, and he is an undisputed authority on this subject. While part owner of the American Vitrified Conduit Company he secured a very large order from the Manhattan Elevated Railway Company, and also an order for 2,500,000 feet of conduit. The subway at Baltimore, where 5,000,000 feet of conduit have been laid, is another instance of the magnitude of the orders which Mr. Lyle has been filling. Another large order was for 3,000,000 duct feet of conduit for the Narragansett Electric Lighting Company, of Providence, R. I.; and the various branches of the Bell telephone system have also given many large orders for this conduit. Mr. B. S. Barnard is associated with Mr. Lyle as vice-president and secretary of the Standard Vitrified Conduit Company, and has personally secured some of the largest orders for this material which have ever been placed.

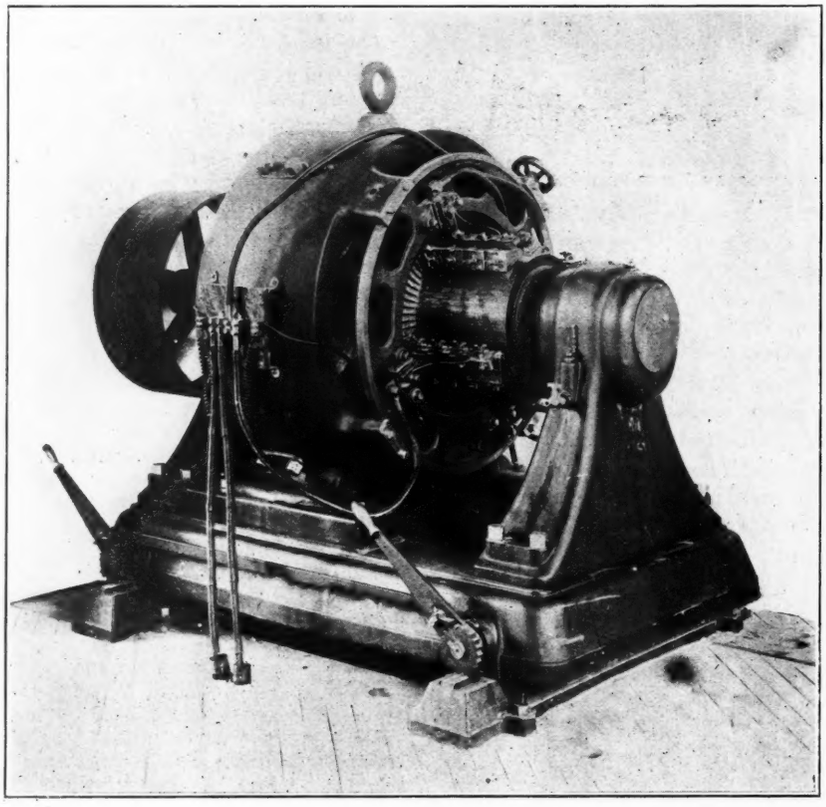
The New York headquarters of this company are at 39-41 Cortlandt street.

### *Open and Enclosed Dynamos and Motors.*

The accompanying illustration shows the style of the standard semi-enclosed motor and dynamo made by Fairbanks, Morse & Company, Chicago, Ill. These machines embody several features of construction which make them worthy of note. As may be seen from the illustration, the brush-rocker on these machines is placed against the pole frame, where it is securely held by the yoke, and is free to turn with the brushes to their best point of commutation. All parts of the rocker and brush-holders are fitted to rings, and the bearings to corresponding plugs, ensuring perfect fit and increased durability.

The commutator is large in size compared with the armature, and the commutator bars are of drop-forged Lake Superior copper.

Set screws are furnished, which engage into tapped holes in the yoke, these being used to adjust the armature centrally with the longitudinally magnetic pull. By turning these screws in or out, just the right play can be given the armature without danger of heating. In changing armatures this is a great convenience.



SEMI-ENCLOSED MOTOR, SHOWING ROCKER-ARM AND BRUSH RIGGING.

gauges and drilled with jigs, and it is at once possible to make the most accurate spacing and avoid sparking troubles.

The core of the armature is built up of thin laminations of annealed iron, with ventilating spaces at intervals, the notches in which the coils are laid being made with a special punching-press, giving correct alignment to the slots without further tooling. On small machines, form-wound coils are used. Large machines use bar-wound armatures, the bars being forged into shape before the insulation is supplied. The armature shaft is made from high-grade steel stock, forged down to one-eighth-inch finished size. All of the journals are fitted to standard steel

The field poles are built up of thin laminations of soft steel, pressed solidly together and securely clamped between malleable iron side pieces. Pole-tips are punched on the blanks, and a slot is made across the face, affording free ventilation and holding the point of commutation practically constant for all loads.

Contact between the pole-piece and pole-rings is made by grinding both surfaces so accurately that, it is claimed, tests show the magnetic resistance is not measurably increased. The shunt field coils are wound on heavy cast-iron forms, each layer being soaked with thick shellac and baked dry. When taken from the form they are hard throughout and perfectly insulated.

### *Integrating Wattmeter for Direct-Current Service.*

The new Duncan integrating wattmeter, several views of which are shown, is of recent development, embodying the most modern features of design and construction, and represents the work of years of experience.

The castings of the meter are made from nickel aluminum, making it light in weight, while every part is easy of access and interchangeable.

The terminals are situated at the top of the meter and connect the series coils with the inleading wires from the circuit, thereby removing these leads away from the retarding magnets at the bottom.

The registering train is made large, and all of its parts are carefully adjusted to ensure ease of operation and freedom from "sticking." The pinions and gearwheels are cut accurately by automatic machinery and assembled by experienced watchmakers. It is also provided with dowell pins, so that when it becomes necessary to remove it from its bracket it can be again put back exactly into its position, enabling the worm-wheel and worm to mesh as originally set.

The dial is of large surface, making it easy to read at a distance, and has a porcelain face. The circles and figures are printed in heavy type and read in kilowatt-hours. Dials can also be furnished to read in "watt-hours," "horsepower-hours," "board of trade units" or "dollars" and "cents."

A feature of this meter is that it is direct reading—that is, the dial shows at all times the actual amount of energy that has been consumed without having to employ a "constant" or "multiplier."

The cast back or support of the meter is provided around its outer edge with a groove that is lined with heavy felt and over which the case closely fits, rendering the meter dust and insect-proof. The dust-proof case is hinged at the bottom and is provided with a single screw at the top which answers for screwing it tightly into position and sealing the meter at the same time.

The series coils are machine wound and heavily insulated with linen tape after which they are immersed in copal varnish, then baked for several hours until they are thoroughly dry. This enables them to withstand any commercial pressure without breaking down.

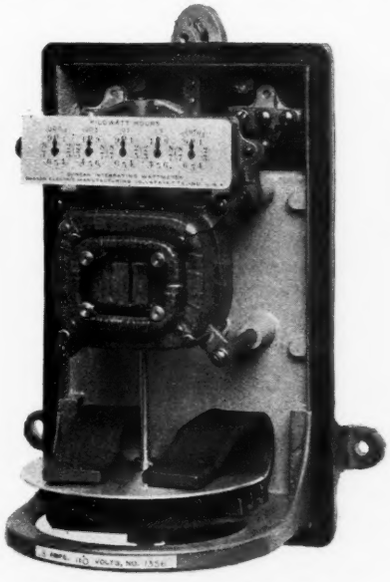
The front series coil can easily be removed from the meter by simply taking out the four screws that hold its corner clamps to the brass supporting rods. This removable feature of the front coil fur-

nishes a quick and excellent means for inspecting the armature.

Great care has been exercised in selecting a resistance wire that will not become brittle and break by being alternately heated and cooled. The wire is wound in sections upon a flat insulated support having saw-tooth edges, so that the difference of potential between each adjacent section is reduced to a minimum.

A special alloy, selected for its durability, has been adopted for the commutator. The segments are accurately cut and insulated from each other and from the spindle so as to prevent any possibility of the armature circuit becoming grounded at this point.

The brushes are easily detached by the removal of two small screws which permits of their being lifted out for inspection without interfering with the shunt-circuit wires. When they are detached they can be thoroughly cleaned and polished if necessary and replaced again without changing their original tension.

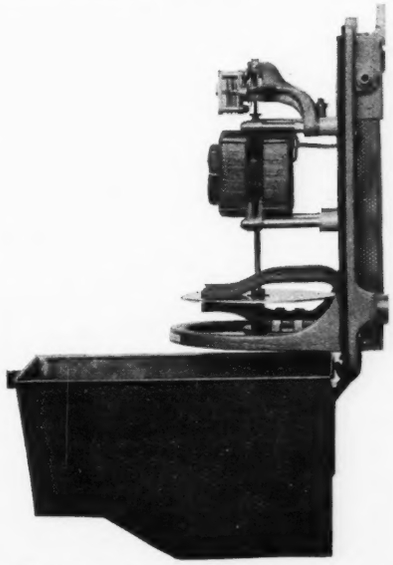


METER, WITH CASE REMOVED.

The spindle is provided with a removable pivot point which is made from the best quality of steel piano wire hardened in mercury, then polished to a fine finish with Vienna lime and rouge. The point of these pivots is carefully rounded off by a machine expressly designed for the purpose, so as to give the least tendency to wear and at the same time reduce the friction to a minimum.

Ceylon sapphires of a great degree of hardness are used. These are made in accordance with a special design, and polished until they are entirely free from scratches or flaws. The size and form of the cup is such as to give the best possible results with the aforementioned pivot point, resulting in low friction and long life.

To protect the jewel against jarring and vibration it is seated upon a small spring which is adjusted to exactly balance the weight of the revolving element, and upon the slightest jar being imparted to the meter the spring takes it up and relieves the jewel from any possibility of being damaged.



SIDE VIEW, SHOWING DETACHABLE AND HINGED CASE.

To those who wish to use the best bearing possible, the makers of this meter state that they can furnish a diamond jewel bearing with this meter. It consists of a diamond step having a sapphire guide mounted upon it, and within which the spindle point revolves, the whole being seated upon a delicately adjusted spring to protect it against jarring in a manner similar to that of the sapphire bearing.

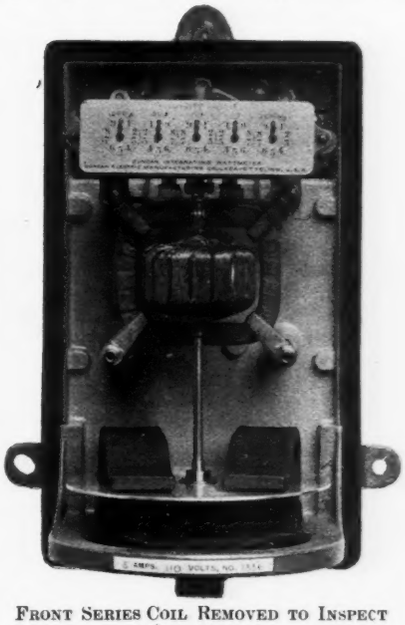
Tests of meters equipped with these diamond jewels have demonstrated their remarkable ability to withstand wear and friction.

Realizing the importance of having magnets that will withstand variations in temperature and mechanical vibration incident to shipping and handling, and still maintain their strength for the purpose of enabling the meter to remain accurate for an indefinite period, a great deal of study has been given and many experiments made with the view of producing magnets whose permanency or magnetic retentivity could be relied upon, and in this direction the makers feel satisfied that their efforts have been successful.

The usual means to compensate for the changes in friction of the meter is also provided to ensure low load accuracy. This consists of a small coil wound with many turns of fine wire and connected in series in the armature circuit and placed within the front series coil adjacent to the armature. It is held in position by four small wire brackets and thumb nuts which prevent it from changing its position during shipment.

The testing constant (K) of each meter is marked upon the disc, and as an example it will be found in the case of a ten-ampere, 110-volt meter to be worked K½. It should be borne in mind that this testing constant is to be used only in testing the meter, and must not be used in connection with the dial when the monthly readings are taken for the purpose of making out the bills for customers. The dials are direct-reading and do not require any constants.

This meter, while especially adapted for measuring the energy or direct-current lighting and power circuits, will also accurately measure alternating currents of any power-factor, wave-form or frequency.



FRONT SERIES COIL REMOVED TO INSPECT ARMATURE.

The Duncan Electric Manufacturing Company, of La Fayette, Ind., is the manufacturer of this meter.

## *The History of the Baldwin Locomotive Works.*

Through the courtesy of Mr. Henry A. Cleverly, we are in receipt of a volume detailing the history of the Baldwin Locomotive Works. This takes us from the original establishment by Matthias W. Baldwin in 1831 up to the present time, and details in an intensely interesting way the great development in locomotive construction, giving details of construction, half-tone illustrations of locomotives and statistics. The book is 6¾ by 9¼ inches, contains 100 pages, is printed on heavy glazed paper, and well bound in green cloth with a decorative title in gold.

### *Direct-Current Ceiling and Bracket Fans.*

For the season of 1903 the Robbins & Myers Company, of Springfield, Ohio, has made but little change in the essential design of its standard direct-current ceiling fans, desk fans and bracket fans.

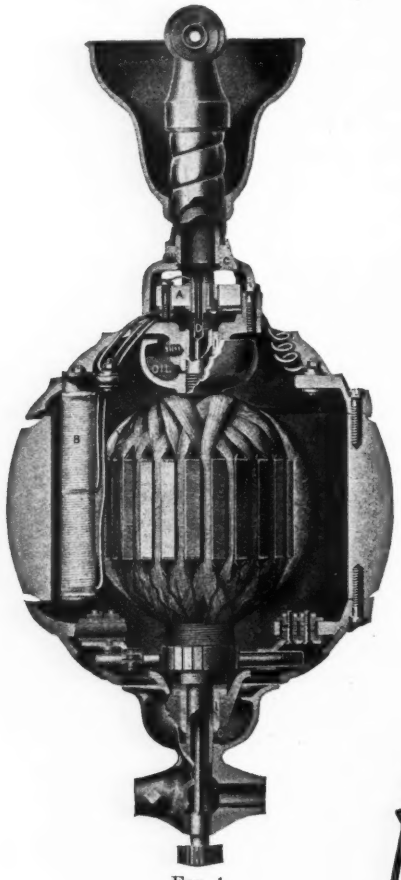


FIG. 1.

Fig. 1 shows the actuating mechanism of the ceiling fan, and while this has been described at previous times, a brief reference to the principal parts will be of interest at this season.

The commutator is built of copper segments cut from hard-drawn bar and insulated with pure mica, mounted on a steel sleeve between steel collars. The lead wires are bound to an asbestos insulating ring on the rear collar and are soldered into slots milled in the corners of the segments.

The brush-holders are of this company's well-known "cartridge" type, consisting of a thin brass shell held in place by a rigid insulated clamp to which the lead wire is fastened. This cartridge contains a five-sixteenth by one and one-quarter-inch round pencil carbon brush, fed radially by a piano wire compression spring.

The shaft is made of steel tubing, accurately turned and polished on lathe centres. The bearings are made of high-grade hardened bearing metal, and are in the form of straight sleeves compressed into seats in the end-plates, which bring them into positive alignment. The design of the bearings is such that the journals are constantly immersed in oil, which is contained in large oil cups. This is plainly shown in Fig. 1.

The magnetic circuit, which is cast in one piece, is formed of a yoke-ring and two pole-pieces with two projecting horns over which the field coils are slipped into place.

The insulating hanger is made of leather, and the switch and resistance tubes are placed in the top of the fan and are connected up independently in such manner that they may be removed without disturbing either the mechanism or connection of the rest of the fan.

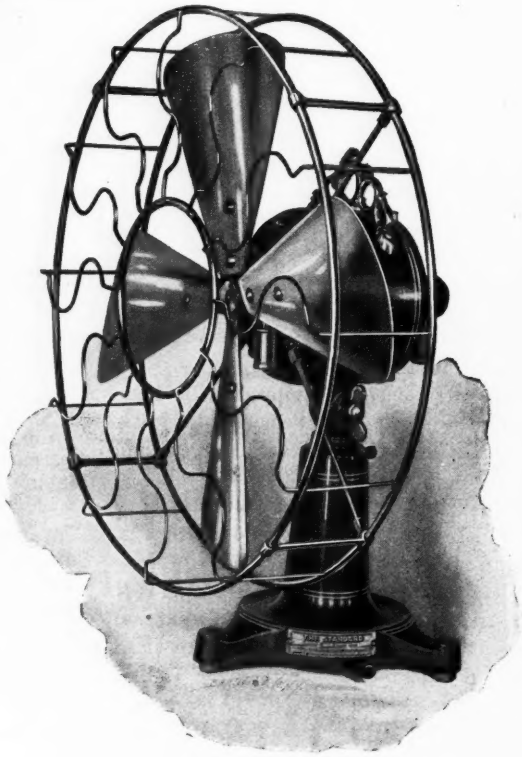


FIG. 3.

Fig. 2 shows the standard direct-current ceiling fan, style "B," and Fig. 3 the sixteen-inch, direct-current desk fan.

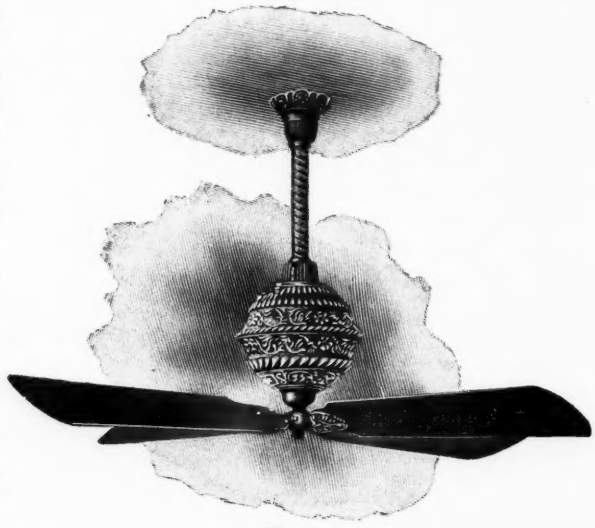
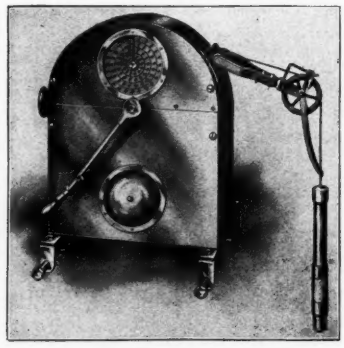


FIG. 2.

### *An Electric Sounding Machine.*

This machine is so constructed that it may be clamped on the rail of any vessel. The sinker or lead is dropped into the water, and upon touching bottom the circuit is closed, which rings the bell in the machine. At the same time, the hand on the dial indicates the exact number of fathoms of water.

The dial has several different readings —one reading for the vessel standing still, one for a speed of four miles per hour, one for a speed of eight miles per hour, etc. The soundings may be taken without checking the speed of the vessel, and twenty fathoms can be registered in less than half a minute. After completing the sounding, the sinker can be wound in by an electric motor contained in the machine, or by a crank fitted for this purpose.



ELECTRIC SOUNDING MACHINE.

This machine is the invention of C. W. Farr, president of the Farr Telephone and Construction Supply Company, Chicago, Ill.

### *Ceiling Fan for Direct Current.*

The D. L. Bates & Brothers Company, of Dayton, Ohio, has recently placed on the market a new ceiling fan for direct current, which is designated as style E,

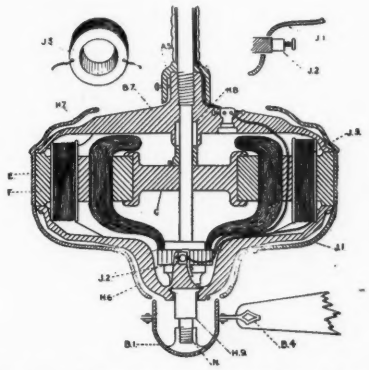


FIG. 1. MECHANICAL FEATURES OF FAN.

a detailed illustration, Fig. 1, showing the mechanical features of the fan.

The field has six round poles, the coils being wound on hard fibre spools which are slipped over the poles and wedged into position. The armature is of the well-known slotted type with form-wound coils properly placed on the armature core.

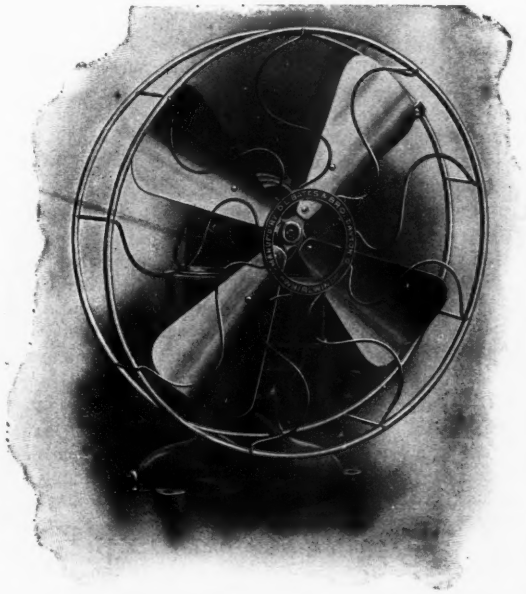


FIG. 2.—DESK FAN.

Both field and armature coils are well distributed so as to give ample heat radiation.

The brushes are carbon of rectangular shape, one-quarter by three-eighths inch, sliding in corresponding brass tube, the latter being heavily vulcanized on the outside for insulation. As the brush-holders extend through openings in the lower ornamental motor cover, renewals may be readily made without removing either the fan blades or the lower motor cover. The bearings are also anti-frictional and interchangeable, the lower bearing being self-aligning with the upper bearing by the weight of the armature. This fan is also furnished with single or three-speed switch attachment if desired. When switch attachment is used the revolving shaft is hollow with a switch stem extending through it engaging with a porcelain switch attached to the top bracket and a key projecting below the blade carrier which is protected by a housing to prevent breakage.

The motor is encased with an ornamental casing which is finished in either nickel, oxidized copper or polished brass. All parts of the motor are made interchangeable, so that repairs, if necessary, can be readily made.

This firm will also continue to make its full line of ceiling, desk, bracket and trunnion fans, which has met with such success in the past. Fig. 2 shows the standard desk fan made by this company.

### *Constant-Potential Interchangeable Enclosed Arc Lamps.*

The accompanying illustration shows the frame and mechanism of a new type of constant-potential enclosed arc lamp which has the meritorious feature of being practically interchangeable, and which can be used for both alternating and direct currents.

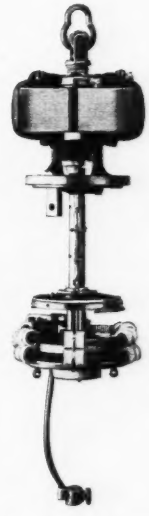
The case used is weatherproof, made of sheet copper of sufficient thickness to ensure stability and strength, and is designed for either outside or inside service. The body of the case is composed of two doors which may be thrown open by turning a latch, thereby exposing the entire working mechanism and making all parts of the lamp accessible.

The clutch is of a ring type, and works directly upon the carbon. The portion in direct contact is of special insulated material and ensures a steady clutch hold and freedom from burning out. Flexible cable contact is used, sliding contacts being obviated.

The actuating mechanism is a laminated horseshoe magnet in the head of the lamp, and is claimed to work equally well under any increase or decrease in voltage, from 6,000 to 16,000 alternations per minute. Between the poles of the magnet is the dashpot, and directly below it a

INTERCHANGEABLE ARC LAMP.

laminated armature attached to the dashpot plungers. The connection from armature to clutch contains a flexible member in the form of an asbestos tube. A double-throw switch, situated on a porcelain base, changes the lamp from alternating to direct current, or cuts off



DETAILS OF INTERCHANGEABLE ARC LAMP.

the current entirely. The resistance wire is located around the porcelain base of the lamp in the direct path of a current of air, ensuring good ventilation. These lamps are manufactured by the Osborn-Morgan Company, Cleveland, Ohio.

# CURRENT ELECTRICAL NEWS

### *DOMESTIC AND EXPORT.*

A STREET RAILWAY MERGER AT LOUISVILLE—It is stated that a merger is projected between the Louisville Railway Company, the Louisville Gas Company, the Louisville Electric Light Company, and the Citizens' General Electric Company. The Louisville Railway Company, the Louisville Electric Light Company and the Citizens' General Electric Company are now maintaining separate power plants, and the various interests, it is announced, have been working for some time towards a consolidation.

TO ERECT POWER PLANTS IN THE CONNECTICUT VALLEY—A bill has been presented to the Connecticut legislature by the general assembly, giving the New Milford Power Company the privilege of building three dams across the Housatonic River at Kent, New Canaan and Salisbury. Each of these dams is to be the site of an electric power generating station. The proposition is to generate sufficient electric power to assure an immediate activity in manufacturing lines along the Housatonic River.

NEW NIAGARA POWER COMPANY GETS FRANCHISE—Acting on the recommendation of the commissioners of the Queen Victoria Niagara Falls Park, the Ontario government has granted the franchise asked for by the new Toronto company for a power plant on the Canadian side of Niagara Falls. The chief members of the company are William MacKenzie, of MacKenzie & Mann, and Lieutenant-Colonel H. M. Pellat and Frederick Nichols. It is understood that the new company will commence preliminary operations at once. The intake will be between that of the Ontario and Canadian Niagara power companies, and the tunnel will be driven under the river bed and will have its portal at the foot of the falls. The work will take two years and will cost $5,000,000. A double cable line will be built from the falls to Toronto, and 20,000 horse-power will be transmitted to that city. As stated before, among the company's customers will be the Toronto Street Railway Company and the Toronto Electric Light Company. The full capacity of the plant will be 125,000 horse-power.

### *PERSONAL MENTION.*

PROFESSOR GEORGE F. BARKER, professor of physics at the University of Pennsylvania, was a visitor to New York last week.

MR. H. C. HAWKS, of Boston, who is identified with several electrical manufacturing enterprises, was a New York visitor last week.

COLONEL H. B. RAMEY, representing the Peerless Electric Company, of Warren, Ohio, has just returned from a month's stay in Europe, having successfully furthered the foreign business of that company.

MR. GEORGE A. McKINLOCK, president of the Central Electric Company, of Chicago, passed through New York last week en route to the West Indies where he will spend a vacation of a month. His family accompanies him.

PROFESSOR W. ELWELL GOLDSBOROUGH, the active chief of the department of electricity, Louisiana Universal Exposition, and professor of electrical engineering at Purdue University, La Fayette, Ind., is stopping in New York for several weeks.

MR. MERRILL G. SMITH, M. E., Stevens, '96, has been appointed associate professor of mechanical engineering in the Clarkson Memorial School of Technology, Potsdam, N. Y. Mr. Smith is at present acting head of the Delaware State College.

MR. HALBERT P. HILL has opened a New York sales office at 135 Broadway for the Storey Motor and Electric Company. Mr. Hill is well known in the electrical field, and has had important connections with several prominent electrical interests.

DR. A. E. KENNELLY, of Harvard University, will lecture before the New York Electrical Society, 19 West Forty-fourth street, New York city, on Wednesday, February 18. His subject will be "The Mexican Gulf Cable." Ladies are invited to the meeting.

MR. WILLIAM E. ATHEARN, assistant electrical engineer of the Western Union Telegraph Company, has been appointed on the engineering staff of the American Telephone and Telegraph Company. Mr. Athearn will be succeeded by Mr. Frank Kitton, of Buffalo.

MR. C. O. BAKER, JR., the platinum importer, returned last week from an extended trip in the West. The demand for the very valuable metal he exports and refines is noticeably increasing in electrical circles, particularly with manufacturers of telephone switchboards.

DIRECTOR WILLIAM S. ALDRICH, of the Clarkson Memorial School of Technology, Potsdam, N. Y., was in town attending the inauguration of the president of the Stevens University last week He also was present at the Institute dinner given in honor of Mr. Carnegie in New York city this week.

MR. CHARLES CUTTRISS, chief electrician of the Commercial Cable Company, and Mrs. Cuttriss, announce the marriage of their daughter Mary Edgeworth and Mr. William L. Adams. The ceremony took place on Saturday, February 7. Mr. and Mrs. Adams will reside in Livingstone, Guatemala, C. A.

MR. W. A. VAIL has recently gone to Minneapolis, Minn., where he will assume the duties of assistant general manager of the Northwestern Telephone Exchange Company, of which company Mr. C. P. Wainman is general manager. The demand for telephones in the important territory of this company is constantly increasing.

MR. AMASA P. FLAGLER, of San Francisco, Cal., loaned the photographs illustrating the article on the Pacific cable in this week's issue of the ELECTRICAL REVIEW. Mr. Flagler is standing immediately to the right of Mr. Edgar C. Bradley, in the group taken during the ceremonies attending the laying of the San Francisco end of the Pacific cable.

MR. CHARLES D. SEEBERGER, the originator of the escalator system, sailed for Europe on the Oceanic, on February 11. Mr. Seeberger has gone abroad to complete arrangements for installing escalators in the stations of the new London Underground Railroad, the preliminary negotiations having been conducted by the Waygood-Otis Company, of that city.

MESSRS. J. RYMER JONES, Raymond C. Barker, Herbert E. Cann, F. C. Crawford, R. H. Mance and S. Manshon, of the India Rubber and Gutta Percha Telegraph Company, submarine cable department, returned this week from participation in the laying of the Pacific cable for the Commercial Cable Company, and sailed for London, England, on the Oceanic, Wednesday of this week. While in New York they were entertained at luncheon by Captain W. L. Candee.

MR. FRANK B. RAE, consulting electrical engineer, New York city, has contracted with the Denver Engineering Works, of Denver, Col., for the installation of a complete plant for the transmission of 600 horse-power, to be used for the operation of hoisting and pumping machinery in the Terrenates mines of the Terrenates Consolidated Mining Company, of Parral, Mexico. Turbine generators will furnish the current, which is to be conveyed about one and one-half miles by aluminum conductors to the hoists and pumping stations. Mr. Rae is consulting engineer for the Terrenates company.

### *AUTOMOBILE NOTE.*

CHICAGO AUTOMOBILE SHOW—The Chicago Automobile Clubs' exhibition, which opens at the Coliseum on February 14, from present indications will be one of the most important in point of numbers of exhibits and departures in design of any heretofore held in this city. While the displays from American manufacturers will be very complete, several distinctive exhibits will be shown from foreign manufacturers. It is stated that there are to be at least fifty more machines exhibited here than were shown at the recent New York exhibition. In connection with the exposition there is to be a meeting of the National Good Roads Commission under the patronage of the National Highway Association, the National Good Roads Association, and the National Association of Automobile Manufacturers. This will be held in the Auditorium, Friday, February 20.

## ELECTRICAL SECURITIES.

The past week has witnessed a slight reaction in the apathy which has characterized the market for some time past. This improved condition has been accompanied by a general rally in prices, and while there has been but little increase in the attention which the outside speculating public has given the market, the commission houses are reporting very much better business.

The present prospect of an early settlement of the Venezuelan affair has also had a healthy effect upon speculation, and the continued reports of prosperity, particularly in the iron and steel trade, have also been an impetus toward better conditions.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 7.

| *New York:* | *Closing* |
|---|---|
| Brooklyn Rapid Transit | 68⅞ |
| Consolidated Gas | 217 |
| General Electric | 193¾ |
| Kings County Electric | 225 |
| Manhattan Elevated | 144⅝ |
| Metropolitan Street Railway | 137 |
| New York & New Jersey Telephone | 167 |
| Westinghouse Manufacturing Company | 213¾ |

The annual meeting of the New York & New Jersey Telephone Company will be held in Brooklyn, March 6. A special meeting will also be held on the same day for the purpose of voting upon a proposition to increase the number of directors from twelve to eighteen.

The Manhattan report for the quarter ended December 31 shows gross earnings of $3,211,372, against $2,827,148 in 1901, an increase of $374,224. Expenses were $1,355,635, a decrease of $49,335 over the same period for 1901. The number of passengers carried was 64,822,675, an increase of 7,596,825.

| *Boston:* | *Closing.* |
|---|---|
| American Telephone and Telegraph | 164⅞ |
| Edison Electric Illuminating | 279 |
| Massachusetts Electric | 93 |
| New England Telephone | 135 |
| Western Telephone & Telegraph preferred | 97 |

| *Philadelphia:* | *Closing.* |
|---|---|
| Electric Company of America | 9¼ |
| Electric Storage Battery common | 79 |
| Electric Storage Battery preferred | 79 |
| Philadelphia Electric | 8 1/16 |
| Union Traction | 46½ |
| United Gas Improvement | 113⅛ |

| *Chicago:* | *Closing.* |
|---|---|
| Chicago Edison Light | 162 |
| Chicago Telephone | 156 |
| Metropolitan Elevated preferred | 88 |
| National Carbon common | 26 |
| National Carbon preferred | 98¾ |
| Union Traction common | 11 |
| Union Traction preferred | 44 |

The Metropolitan Elevated has declared the semi-annual dividend of 1½ per cent, making 3 per cent for the year, payable February 28. Books close February 14 and reopen February 20.

## NEW INCORPORATIONS.

JERSEY CITY, N. J.—Electric Car Lighting Company. $100,000.

INDIANAPOLIS, IND.—Wabash Home Telephone Company. $10,000.

FOREST CITY, IOWA—Northern Telephone Company. Increased to $100,000.

BALDWINSVILLE, N. Y.—The Ontario Telephone Company. Increased from $20,000 to $40,000.

SCHENECTADY, N. Y.—The Fort Wayne Electric Works. Increased from $800,000 to $1,000,000.

JERSEY CITY, N. J.—Missouri River Power Company. Increased from $2,000,000 to $2,200,000.

ALBANY, N. Y.—The Fonda, Johnstown & Gloversville Railroad Company. Increased from $1,950,000 to $2,500,000.

MINNEAPOLIS, MINN.—Viborg & Centerpoint Telephone Company. $10,000. Incorporators: M. V. Olsen and F. L. Larson.

MADISON, WIS.—The Werley Telephone Company. $800. Incorporators: Sylvester Frey, August Wellner and H. A. Monteith.

DES MOINES, IOWA—Arion Telephone Company. $10,000. Incorporators: J. L. Maurer, W. B. Evans, E. R. King and W. B. Nelson.

JERSEY CITY, N. J.—Eastern Electric Contract Company. $100,000. Incorporators: Le Grand Bouker, W. Mondo Greene and Charles N. King.

AUSTIN, TEX.—Clieburne Telephone Company. $60,000. Incorporators: F. M. Kirby, B. C. Allen, A. C. Campbell, J. H. Keith and F. B. McElroy.

ST. PAUL, MINN.—Great Northern Power Company. $100,000. Incorporators: F. A. Cokefair, E. C. Bacot, C. C. Kritzer, William Harrison, all of Duluth.

WHEELING, W. VA.—Fairmount Home Telephone Company. $25,000. Incorporators: C. L. Michael, F. P. Kelly, M. M. Ogden, C. W. Arnett and S. B. Harr.

NEW YORK, N. Y.—International Tide Power Company. $10,000. Directors: Samuel Herz and H. Grand, New York, and Henry Sinclana, Croton Falls.

TITUSVILLE, FLA.—The Indian River Telephone Company. $5,000. Incorporators: W. H. Harris, H. Jennings, George E. Coon, A. C. Dittmar and G. S. Tucker.

JERSEY CITY, N. J.—Mansfield and Eastern Traction Company. $500,000. Incorporators: Charles J. Meiley, James J. Maguire, James W. Galbrant and William J. Fentz.

COLUMBUS, OHIO—The Utica & Homer Telephone Company. $40,000. Incorporators: Dwight E. Sapp, Frank L. Beam, Harry C. Devin, R. M. Greer, William C. Sapp.

JERSEY CITY, N. J.—Eickemeyer Electric Pump Company. $50,000. Incorporators: Carl Wickman, Yonkers, N. Y.; John W. Avery and S. R. Bullock, New York city.

RAVENNA, OHIO—The Portage County Telephone Company. $100,000. Incorporators: Fred E. Smith, S. D. Brown, J. E. Bronson, Francis Seabring and W. E. Slaganby.

DENVER, COL.—Rifle Creek Telephone Company. $10,000. Incorporators: C. J. S. Hoover, Richard Parris, George E. Clarkson, Benjamin H. Thompson and Elijah R. Parker.

PERRYSBURG, OHIO—The Standard Telephone Company. $100,000. Incorporators: John Bamer, Summer Cottingham, Wilbur D. Mudge, Azor Thurston and Merton L. Bamer.

PALESTINE, TEX.—Palestine Light and Power Company. $150,000. Incorporators: E. J. Spencer, of St. Louis; J. S. Tritle, R. A. Greer, M. C. Wade and R. W. Rodgers, all of Texarkana.

COVINGTON, KY.—The Covington, Bradford & Versailles Traction Company. $15,000. Incorporators: B. M. Hopkins, E. C. Spring, Dennis Dwyer, Albert Emanuel and T. Russell Robinson.

OBLONG, ILL.—The Crawford County Mutual Telephone Company. $25,000. Incorporators: David J. Chamblin, Charles W. Chamblin, Lewis B. Chamblin, E. Callahan, P. G. Bradbury, C. S. Jones and C. Barlow.

ALBANY, N. Y.—The Bush Terminal Railroad Company. $15,000. Directors: Irving T. Bush, F. B. Studwell, Herbert Broughton, Henry Greene, T. C. Horton, Arthur Carter, William A. Brodie, R. C. Simonds and Joseph Nash.

ALBANY, N. Y.—The Detroit Edison Company. $6,000,000. Directors: Charles W. Wetmore, George R. Sheldon, Edwin M. Bulkley, Charles A. Coffin, William F. White, Alfred Jaretzki, Albert S. Ridley, Henry W. Clark and George H. Olney.

BEAUMONT, TEX.—Beaumont Traction Company. $600,000. Incorporators: Ben Johnson, of Natchez, Miss.; Morris Block, William P. Ellison and L. F. Chester, of Beaumont; Harry K. Johnson, of Greenville, Miss.; George J. Baldwin, of Savannah, Ga., and H. L. Rogers, of Boston, Mass.

### TELEPHONE AND TELEGRAPH.

FULTON, N. Y.—The Fulton Telephone Company contemplates making extensive improvements to its lines in the early spring.

BINGHAMTON, N. Y.—A telephone line is being built from Triangle to Whitney's Point. It will be completed in the near future.

JOHNSTOWN, PA.—The Salix Telephone Company has completed its Foustwell extension, and has made connections with the system which reaches this place.

AUGUSTA, GA.—The Bell Telephone Company has begun work on its underground system in this city, and will shortly begin the construction of its new building.

ONEONTA, N. Y.—The Oneonta Telephone Company has completed the purchase of the lines of the Milford Telephone Company, and will at once assume possession.

NEWCASTLE, PA.—A mortgage for $200,000 has been recorded here, made by the Union Telephone and Telegraph Company to the Dime Savings and Trust Company, of Erie.

SCRANTON, PA.—Arrangements have been made for the sale of the Scranton & Stroudsburg Telephone Company to the Pennsylvania Telephone Company. The transfer will be made April 1.

PHILADELPHIA, PA.—The southern system of the Keystone Telephone Company has been inaugurated, and all the important points in Pennsylvania, Delaware, New Jersey and Maryland can now be reached.

NEWARK, N. J.—The common council of Nutley has granted a fifty-year franchise to the New York & New Jersey Telephone Company. It is said a very complete system will be installed, including an all-night service.

HOOSICK FALLS, N. Y.—The Eastern New York Telegraph and Telephone Company, of Hoosick Falls, has made a five-year contract with the Rensselaer Telephone Company, of Troy, for the interchange of toll business.

BALTIMORE, MD.—The new Maryland long-distance telephone line to Philadelphia has been opened. It will connect Baltimore with about 10,000 subscribers in Philadelphia, and will also connect with towns in Pennsylvania and New Jersey.

ROCHESTER, N. Y.—A farmers' telephone line will soon be started from Wolcott. The main line will run from Wolcott to South Butler, and will be extended to Red Creek. Branches will run to Furnace Village and to North Wolcott.

DALLAS, PA.—At a recent meeting of the stockholders of the Farmers' Telephone and Supply Company the matter of connecting with the Bell and Centremoreland companies was discussed, and it is understood that connection with both lines is now a matter of but a short time.

RICHMOND, VA.—The physical property of the Richmond Telephone Company was sold recently by the Virginia Trust Company to Warner Moore & Company, whose bid was $10,000. It is believed that the purchaser acted for the Southern Bell Telephone Company which recently obtained the city council's permission to take over the business of the independent concern.

NEW BERLIN, N. Y.—At the annual meeting of the New Berlin Telephone Company, held recently, the following officers were chosen for the ensuing year: President and manager, F. A. Smith; vice-president, I. L. Richer; secretary and treasurer, G. H. Willard. The company has made exclusive arrangements with the new Home Telephone Company, of Utica, and as soon as the weather will permit will begin building the remaining five miles between Bridgewater and Cassville necessary to connect with that system.

BERGEN, N. Y.—The organization of the Bergen Telephone Company, which proposes to build and operate local telephone lines in connection with the Bell Telephone Company, has been completed. The following are the names of the officers and directors: President, George M. Gillette; vice-president, J. S. Gleason; secretary, H. C. Miller; treasurer, C. E. Housel; directors, E. S. Miller, George Sands, William E. Gillette, Dr. W. F. Smeltzer, George E. Best, Dr. Robert M. Andrews. An application for a franchise has been made to the village board.

### ELECTRIC LIGHTING.

LIBERTY, MO.—H. J. Arnold, of Denver, Col., is making arrangements for the erection of a new electric light plant in this village.

FORT DODGE, IOWA—The Fort Dodge Light and Power Company is to expend from $275,000 to $300,000 in improving its plant in this city. Work is to be commenced at once.

MINNEAPOLIS, MINN.—The Minneapolis General Electric Company is preparing to make a number of extensive improvements to its plant in this city. About $300,000 will be expended.

JOHNSTOWN, PA.—Officials of the Consumers' Light, Heat and Power Company state that work upon the erection of the company's plant will begin very shortly. The cost of the plant, not including the outside wiring or conduits, will be about $115,000.

GOSHEN, N. Y.—Central Valley & Highland Mill Electric Light and Power Company has been incorporated at Albany to furnish light, heat and power in the villages of Highland Mills, Central Valley, Monroe and Turners, Orange County. The capital of the company is $140,000.

SHELBYVILLE, IND.—A thirty-year option for a valuable piece of ground has been closed by the Citizens' Water, Heat, Light and Power Company, with the privilege of purchasing it at the end of that time. The company will erect its plant on the site secured, at a cost of about $300,000.

TROY, N. Y.—The Watervliet Illuminating and Power Company has filed articles of incorporation. Business will be carried on in the village of Green Island and in the towns of Colonie and Watervliet. The directors for the first year are: Eugene A. Ashley, Brice E. Morrow, C. S. Pedrick, Jr., all of Green Island.

KALAMAZOO, MICH.—The Otsego Power Company, with a capital of $200,000, filed its articles of association recently. The officers are Glenn D. Smith, of Jackson, chairman; Edward H. Marranane, of Grass Lake, secretary, and Jacob H. Bootes, of Jackson, treasurer. The company purposes to build a large dam in the Kalamazoo River in Allegan County.

BRECKENRIDGE, MINN.—Vernon A. Wright, of Fergus Falls, who is the owner of an extensive water power near that place, purposes to utilize it by furnishing electric light and power to a large area of the surrounding country. At present he is planning to furnish light and power to Fergus Falls, Wahpeton, Breckenridge, Foxhome, Campbell and several smaller towns.

CEDAR FALLS, IOWA—Frank Anderson and Roger S. Clay, of this city, and Acquilla Walker, of Janesville, have incorporated the Cedar Falls & Janesville Power Company, with a paid-up capital of $100,000. The purpose of the company is to develop the water power of the Cedar River at Janesville, and establish an electric plant there to furnish power for manufacturing establishments, etc.

MINNEAPOLIS, MINN.—Articles of incorporation have been filed by the St. Croix Falls Minnesota Improvement Company. The object of the company is to develop water power. The capital stock is placed at $50,000. The incorporators are: M. B. Koon, president; E. A. Merrill, vice-president; Ary B. Zonne, secretary; Edward P. Wells, treasurer. The company, in connection with the St. Croix Falls Improvement Company, will develop the St. Croix Falls water power, and an option has been secured on Neever's Dam above the falls of the St. Croix.

GRAND RAPIDS, MICH.—At the annual meeting of the directors of the Grand Rapids Edison Company, held recently, it was decided to equip an extensive power plant for generating purposes on the Flat River above Lowell. These power rights are the same the company acquired through the recent consolidation of companies, and the Edison company has recently had men making surveys and estimates of the work. The dam will have a fall of thirty feet, and will furnish 1,000 horse-power. Work is to be commenced at once, and it will take fully a year to complete the undertaking. The cost is estimated at $250,000, and the power generated will be brought to Grand Rapids and distributed from this point. The following officers were elected to serve during the year: President, Daniel McCoy; vice-president, Daniel McCool, of Newaygo; secretary and treasurer, Thomas F. Bechtel.

## INDUSTRIAL ITEMS.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., describes in its bulletin No. 75, some reasons why chloride accumulators have been so successful in installations for the electric lighting of railway cars.

THE GARVIN MACHINE COMPANY, Spring and Varick streets, New York city, has just issued a new catalogue, No. 2, descriptive of its plain milling machines, and a complete telegraphic code. The machines are accurately described, and the illustrations easily understood.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., is sending its 1903 picture calendar to its friends. This represents in very vivid colors a child holding a telephone receiver to the ear of a very much excited puppy. The telephone instruments are, of course, of the standard Kellogg make.

THE CHARLES E. DUSTIN COMPANY, 11 Broadway, New York city, has ready for immediate delivery a very complete line of electrical equipments, both of new and second-hand material. This includes electric machinery, steam engines, boilers, railway generators, motors, and street car and locomotives.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a brisk demand for its 1903 model push-button switch. While these orders are quite large, the company is able to meet them promptly. The larger contractors doing the high-grade work it is stated are the most frequent buyers of this material.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is mailing a decorative postal card, embellished with a half-tone reproduction of the proposed Textile Arts Building at the St. Louis Exposition, 1904. The Commerical Electrical Supply Company has the contract for all electrical supplies for this building.

THE CONNECTICUT DYNAMO AND MOTOR COMPANY, with offices at 526 West Twenty-fifth street, New York city, is the manufacturer of "Connecticut" motors and generators. An attractive circular recently issued by the company describes and illustrates the motors and generators of the enclosed type made by this company.

THE DIELECTRIC MANUFACTURING COMPANY, 3820 Manchester avenue, St. Louis, Mo., manufacturer of "Dielectrol" insulating compound, has just published a pamphlet containing some testimonials from very high class users of insulated materials. Fac-similes of these testimonials the company will be pleased to send upon request.

THE MECHANICAL BOILER CLEANER COMPANY, Chicago, Ill., has just received a letter from the Omaha & C. B. Railway and Bridge Company, stating that the "Garrigus" cleaners put in its boilers in 1898 are still working perfectly. The company also says that the cleaners have made its boilers much more efficient and reduced expenses greatly.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., has favored some of its friends with a very attractive paper-weight in the shape of a nickel-plated pedestal, in which are mounted two bronze reproductions of a medallion, the face of which bears a miniature of Edwin Reynolds, chief engineer, and the reverse side the West Allis works, designed by Mr. Reynolds.

L. W. STANTON has drawn up specifications for the equipment of multiple switchboard for party-line service for the local telephone company of Bellevue, Ohio. Each court circuit will be equipped with four party selective indicating keys, and the installation will be modern in every detail. The power plant will be operated from a gas engine installed by the company.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, is paying particular attention to grinding all globes perfectly. The careful attention given to this detail, together with the use of the highest grade of glass, allows the company to assure its customers of a very fine quality of inner globes. A fine catalogue just issued by the company gives a description of Shelby inner globes for all makes of arc lamps, and also shows in diagram the dimensions and shapes of the inner globes. This catalogue will be sent to any one interested upon request, and should be possessed by every one interested in this direction.

THE PAIRPOINT CORPORATION, New Bedford, Mass., manufacturer of silverware and cut glass, and specialties in blown glass, has equipped its factory so as to give special attention to making heavy tubes varying in size from seven-eighths to two inches in diameter. These glass tubes are made with heavy walls for heating purposes, and particularly for conveying circuits for high voltages.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is distributing to the trade a pamphlet describing its Alpha and Omega toggles, two devices for which it is expected there will be a large demand. These toggles are strong, well made and low priced. The pamphlet also contains a description of the new "Zero" solderless lug. This pamphlet will be sent to any one having occasion to use these materials.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued its 1903 catalogue of fan motors and ceiling fans for alternating currents. This catalogue shows a very complete line of automatic start swivel and trunnion two-speed desk fans, bracket fans, swivel base fans, two-speed ceiling fans and electrolier fans for alternating current, and exhaust fans for direct current. This catalogue will be sent upon request.

THE LYON METALLIC MANUFACTURING COMPANY, 137 and 139 Fulton street, Chicago, Ill., is making many successful adaptations of metal pans and boxers for use in factories and workshops. These metal trays and boxes are especially valuable in electrical workshops where a great many varieties of small materials are handled. The Lyon Metallic Manufacturing Company will be pleased to send descriptive illustrations upon request.

THE ELECTRIC MACHINERY COMPANY, Minneapolis, Minn., has reproduced several commendatory letters received by it with regard to recent installations of electrical machinery. One is from Winston Brothers' Company, contractors of Minneapolis, with relation to the installation at the Globe Building of the same city, and the other from the Minneapolis Mill Company of the same city. Both of these installations are apparently giving perfect service.

THE IRVINGTON MANUFACTURING COMPANY, Irvington, N. J., is the manufacturer of a complete line of forged steel tools. The company makes a specialty of linemen's box-joint, side-cutting pliers and round-joint, side-cutting pliers. The company also manufactures a number of types of splicing clamps, wire and sleeve clamps, linemen's climbers, "come along" clamps, and other tools for construction purposes. Illustrated catalogues will be mailed on request.

THE SPEER CARBON COMPANY, St. Marys, Pa., is meeting with remarkable success in the reception of the "high-grade" brush which this company has placed on the market. This brush, it is claimed, is very reliable in service, carrying excessive loads without deterioration and bringing about no commutator troubles. The company will be pleased to submit samples for examination, and where commutator troubles exist, solicits the opportunity of quoting information.

THE ARLINGTON MANUFACTURING COMPANY, Canton, Ohio, manufactures the Arlington vegetable boiler composition for use in marine, tubular and water-tube boilers, for preserving steam boilers, preventing encrustation, scale, corrosion and pitting. This composition is a vegetable extract which converts the lime and magnesia, holding them in suspension in the form of a light precipitate which is blown or washed out of the boiler. The company will be pleased to send information upon request.

THE AMERICAN ELECTRICAL HEATER COMPANY, Detroit, Mich., manufactures a most conveniently designed electric stove, especially adapted for offices, waiting rooms, bath rooms, etc. The moment the current is turned on these stoves are claimed to produce the most perfect heat known, and being free from all odors and combustion, are claimed not to vitiate the atmosphere of the room. These stoves are claimed to be absolutely indestructible.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have issued a booklet intended for prospective students entitled "One Thousand and One Stories of Success." This has been very carefully prepared, and the different states of the Union are taken alphabetically, not less than a dozen names and addresses in each state being mentioned. This valuable list is

supplemented by miniature photographs of the successful ones, with a signed statement from each.

JAMES L. ROBERTSON & SONS, 204 Fulton street, New York city, call particular attention to the quality of the rubber used as a core in the centre of "Eureka" packing. This rubber is put through a heat test, as well as for resilience, and in this way the company is able to assure users that it will not become hard nor lose its elasticity under normal conditions of engine work. One of the oldest products of this company, the Hine eliminator, patented in 1888, is still very popular, and is the subject of increasing attention and demand.

WESTINGHOUSE, CHURCH, KERR & COMPANY, Pittsburg, Pa., have reprinted from the proceedings of the twenty-first annual meeting of the American Street Railway Association for 1902 the paper on "The Steam Turbine, Its Commercial Aspect," by Edward H. Sniffin. This paper is written with a special reference to the Westinghouse steam turbine, and the text is illustrated by sectional and half-tone engravings of working installations. A valuable feature is the tests which are given in tabulated form as a supplement to the curve sheets.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has been appointed general sales agent for the "Toler" system of conduit boxes. This line of boxes is extensive enough to meet every possible condition and of any size, shape or style. A complete catalogue will be ready for distribution very soon, and will be mailed upon application. The Electric Appliance Company will send to any one interested a circular describing fully the "Noxem" receiver. The company claims that this receiver is an absolute safeguard against the user receiving a shock through exposed metal parts.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, is the manufacturer of the Barney brick conveyor system. A recent catalogue issued by this company describes the Barney brick conveyor, and shows a number of illustrations in both half-tone and diagram of this method of brick handling. The company also manufactures a complete line of lifting, conveying and power transmission machinery, such as belt conveyors, bucket elevators, pan and apron conveyors, chains, screens, mortar mixers, horse-powers, storage battery locomotives, trolley electric locomotives, and excavators and holders.

THE NATIONAL CONDUIT AND CABLE COMPANY, Times Building, New York city, manufacturer of bare copper wire, weatherproof wires and cables and lead-covered wires and cables for telephone, telegraph, electric light and power work, issues a valuable document entitled "Copper Gossip." This portrays the general business outlook, the present prices of copper, and a comparison with the prices of last year. A paragraph relates to the London copper market, and copper mining developments are also treated intelligently and comprehensively. European copper statistics and the United States production and exports of copper are also included in this pamphlet.

JOHNSON & MORTON, Utica, N. Y., manufacturers of panel boards and accessories, will mail on application a recently printed pamphlet containing a complete list of all styles of panel boards and the fittings that are commonly used in connection with them. This list is in a form which is most convenient for reference. The dimensions are given for each style, so that the user can tell exactly what space must be allowed for placing the panels, and these dimensions have been made as small as possible in each case. All of the spacings on the panels are strictly in accordance with the rules of the National Board of Fire Underwriters, and the finish of all parts is as nearly perfect as it is possible to make it.

ROSSITER, MacGOVERN & COMPANY, Incorporated, 141 Broadway, New York city, will contract to furnish and erect, ready for operation in sixty to ninety days, complete power station installations for electric railway and lighting plants. In addition to the complete installation for the stations, this company is able to furnish promptly closed cars with motor equipments, and also open cars with motor equipments. This company recently supplied the Oakland Consolidated Transit Company, of Oakland, Cal., with 2,000 kilowatts of generators and engines. Parts of these were from the recent purchase by Rossiter, MacGovern & Company from the Metropolitan company, of this city, and a portion of the apparatus was purchased new for this purpose.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., has recently closed a number of contracts, among which may be noted the following: The Buckeye Construction Company, Shawhan, Ky., for a 100-capacity drop switchboard; D. A. Oliver, Scottsville, Ky., 100-capacity drop switchboard; W. A. Eckels, Rudd, Iowa, 50-capacity drop switchboard; Clarington Telephone Company, Clarington, Iowa, 100-capacity drop switchboard; Montrose Telephone Company, Montrose, Pa., 120-capacity drop switchboard; E. V. Hauser, Havre, Mont., 100-capacity board; Buckeye Construction Company, Centreville, Ky., 100-capacity drop switchboard; Pike County Telephone Company, Pleasant Hill, Ill., 50-capacity drop switchboard, and the State Line Telephone Company, Elmo, Mo., 100-capacity drop switchboard.

THE STOREY MOTOR AND ELECTRIC COMPANY, which recently enlarged its shop equipment at Harrison, N. J., broadening its line of machinery so that it covers anything that can possibly be used in work involving the direct attachment of motors to machine tools, printing-presses, etc., as well as a full line of open and enclosed constant-speed power motors and the necessary generators, has opened up its New York sales office in the Corporation Trust Building, 135 Broadway. The services of Mr. Halbert P. Hill, who retires from the General Incandescent Arc Light Company, have been secured as manager. This company is now undertaking the most difficult and exacting work in the line above stated, and the new representative, Mr. Hill, expects to be able to personally investigate the needs of the trade, and will be able to promise prompt deliveries.

THE AMERICAN CONDUIT COMPANY, Chicago, Ill., announces that it will hereafter conduct the business of the Electrolysis-Proof Manufacturing Company. Mr. W. F. McCarthy will continue as manager of the Chicago branch. The officers of the American Conduit Company are John S. Cravans, president; George H. Barker, vice-president, and A. W. Buchanan, secretary and general manager. The factories of the American Conduit Company are at Chester, Pa., Chicago, and Los Angeles, Cal. Its offices will be as follows: 720 Arcade Building, Philadelphia; 822 Manhattan Building, Chicago, and 336 Macy street, Los Angeles. The original intention of the company was to maintain a business office at the Chester factory, but this plan has been reconsidered, and it is now the purpose to have this office in Philadelphia rather than at the factory at Chester.

THE PHELPS COMPANY, 29 Rowland street, Detroit, Mich., maker of "Hylo" incandescent lamps, has recently received a letter from Mr. S. B. Pike, of the Missouri Edison Electric Company, in which it is stated that this company has decided to renew "Hylo" lamps for its customers without charge, on the same basis as they renew standard sixteen-candle-power lamps. Another very interesting letter received by the Phelps Company is from the Lamp Testing Bureau, to the effect that of two lots of "Hylo" lamps—ten lamps in each lot—one lot has been burning for 3,000 hours and the other for 4,000 hours. The Lamp Testing Bureau writes to enquire as to how much longer the Phelps Company desires the test continued. Mr. W. J. Phelps, in reply to this letter, stated that it would be a good idea to burn the "Hylos" out on this line if it took all summer.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is furnishing the following electrical apparatus for a new interurban railway, forty miles in length, which is being built from Rochester through Canandaigua to Geneva, N. Y.: Two 650-kilowatt, three-phase, 3,000-alternations, 390-volt, engine-type alternators, which will be arranged for direct connection to cross-compound engines running at 150 revolutions per minute; seven 300-kilowatt, three-phase, rotary converters; four 500-kilowatt and nine 200-kilowatt, oil-cooled transformers arranged for transforming from 390 to 16,500 volts, and two 37½ kilowatt, direct-current, engine-type exciters operating at 320 revolutions per minute, together with the switchboards, high-tension switches and lightning arresters for the main generating station and three substations. This road will be known as the Rochester & Eastern Rapid Railway. The Comstock-Haigh-Walker Company is building and equipping the line, and expects to have it in operation by next July.